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This section describes USACE and SCWA activities and operations under baseline conditions. The environmental baseline provides the foundation for developing proposed changes in operations to benefit listed fish species in the Russian River watershed, which are described in Section 4.0. Project actions implemented since the MOU was signed in 1997, as well as current actions that would be continued, are part of the proposed project (see Section 4.0). The potential effects of these actions on listed species will be evaluated in Section 5.0.

The effects of the activities and operations under baseline conditions were evaluated in detail in *Interim Reports 1* through *8* (ENTRIX, Inc. 2000a, 2000b, 2001d, 2001a, 2001b, 2001c, 2002b; FishPro and ENTRIX, Inc. 2000). These reports are available on USACE's web site (http://www.spn.usace.army.mil/ets/rrsection7). Results of these analyses are included in the descriptions of the activities and operations. Section 3.8 integrates these factors to identify the project activities affecting listed fish species in the Russian River Watershed.

3.1 COYOTE VALLEY DAM AND LAKE MENDOCINO

Three major reservoir projects provide water supply storage for the Russian River watershed: Lake Pillsbury on the Eel River, Lake Mendocino, and Lake Sonoma. SCWA must make water supply releases from Lake Sonoma and Lake Mendocino in accordance with criteria established in 1986 by D1610 (SWRCB 1986b). Flow regulation under D1610 is described in detail in Section 3.3. Releases from Lake Pillsbury are discussed in Section 2.1.

Lake Mendocino is a multi-purpose reservoir that provides flood protection to areas below Coyote Valley Dam; supplies water for domestic, municipal, industrial, and agricultural uses; and supports hydroelectric power generation. Lake Mendocino is the major component of USACE's Coyote Valley Dam (see Figure 2-1 in Section 2.1). It controls runoff from a drainage area of approximately 105 square miles and also stores water diverted by PG&E into the Russian River basin via the PVP.

Coyote Valley Dam is a rolled earth embankment dam with a crest elevation of 784 feet above mean sea level (MSL), which is 160 feet above the original streambed. Lake Mendocino, which began storing water in 1959, had an original design capacity of 122,500 AF at the spillway crest elevation of 764.8 feet above MSL. A bathymetric (water-depth) study in 1985 (SCWA and USGS 1985) indicated that the storage capacity was 118,900 AF, which is 3,500 AF less than its original capacity. A more recent bathymetric survey conducted in 2001 indicated that the current storage capacity is 116,500 AF (P. Pugner, USACE, pers. comm., 2003).

3.1.1 LAKE MENDOCINO

Lake Mendocino has distinct pools for water supply and flood control, determined by the season and elevation of the water surface. The total water supply pool capacity shared by SCWA and MCRRFCD in Lake Mendocino was originally 72,300 AF, but has been reduced by sedimentation to approximately 69,000 AF (USACE 2001). The capacity above 69,000 AF is used for flood control. SCWA and the MCRRFCD share state water-rights permits to store up to 122,500 AFY in the reservoir. SCWA determines releases to be made from the water supply pool. However, when the water level rises above the top of the water supply pool (seasonally between elevation [El.] 737.5 feet and El. 748 feet above MSL) and into the flood control pool, USACE determines releases. USACE also determines releases during inspections and during maintenance and repair of the project.

The elevation of the top of the water supply pool in Lake Mendocino changes in the fall and spring months. Approximately 20,000 AF of additional water can be stored for water supply in the flood control pool toward the end of the rainy season (March to April) as the need for flood control storage decreases. USACE decides whether this additional water storage capacity becomes available in March or April. The maximum summer pool level is held at 748.0 feet beginning as early as March 31 through October 12. In October, when the need for flood control storage increases again, the reservoir level must be reduced to its winter level. October 13 through October 31, the required flood space increases uniformly until it reaches the full flood space reservation requirement for the winter at pool elevation 737.5 feet (68,400 AF), where it remains until March 31. If the USACE determines that the flood control functions of the project will not be impaired (e.g., under *dry* water supply conditions), reductions to the flood control space could occur as early as March 1.

The operation of Coyote Valley Dam has altered year-round mainstem flow patterns. Dam operations reduce discharge peaks, prolong winter high flows, and increase summer flows above Healdsburg to an average of 200 cfs (Steiner 1996). During the rainy season (October through May), natural streamflow (rather than reservoir releases) accounts for most of the flow of the Russian River. During the dry season (generally June through September, although it may be a longer period), the natural flow in the Russian River downstream of Coyote Valley Dam is augmented by water released from Lake Mendocino.

Winter operations primarily involve storing water in the dedicated flood control pool while releases are made for flood control. When possible, releases from Coyote Valley Dam are controlled so that flow at Hopland, approximately 14 miles downstream, does not exceed the 8,000-cfs channel-capacity of the mainstem. This is sometimes not possible when inflow to the lake is very high or when uncontrolled flows in the mainstem Russian River exceed 8,000 cfs.

Coyote Valley Dam has a minor effect on winter flood flows at Healdsburg because it regulates only 13 percent of the watershed above Healdsburg (and only 7 percent of the entire watershed) (USACE 1986b). USACE's 1986 study evaluated the effect of Coyote Valley Dam on the flood of 1964. The results indicated that operation of the dam reduced the flood peak by 29 percent at Hopland, 14 miles downstream; 21 percent at Cloverdale, 30 miles downstream; 11 percent at Healdsburg, 58 miles downstream; and 7 percent at Guerneville, 74 miles downstream.

Releases from the Coyote Valley Dam water supply pool are determined by SCWA, subject to the requirements of D1610. During the summer months, SCWA releases water from Lake Mendocino to meet water supply demands between Lake Mendocino and Healdsburg, and to meet the required minimum flow at Healdsburg. In general, SCWA does not make discretionary releases from Lake Mendocino for diversions by SCWA or any other diverters below Dry Creek. Releases from Lake Mendocino are made from an outlet tunnel 128 feet below the dam spillway crest elevation at the bottom of the reservoir. This means the coolest water in the reservoir is released during summer months, until low water levels result in a loss of thermal stratification and depletion of the cold water pool (which often occurs by September).

3.1.2 Flood Control Operations of Coyote Valley Dam

USACE's main objective for flood control releases from Lake Mendocino is to prevent flood flows on the East Fork Russian River from contributing to overbank flood stages on the Russian River below Coyote Valley Dam, to the extent possible. The specific criteria for flood control operations are described in the Water Control Manual for Coyote Valley Dam (Coyote Valley Dam Water Control Manual) (USACE 1998b). The general criteria for releases from the flood control pool call for successively increasing releases in three stages as reservoir levels rise toward the emergency spillway. The Hopland streamflow gage, 14 miles downstream of Coyote Valley Dam, is the most downstream monitoring point for decisions affecting flood control releases from Lake Mendocino.

USACE limits releases from Lake Mendocino to prevent local flooding at Hopland that generally occurs when flows exceed 8,000 cfs. Because bank sloughing is likely to occur when flows decrease too rapidly, USACE has imposed a maximum ramp down rate of 1,000 cfs per hour for Lake Mendocino.

USACE has developed modified guidelines for the rates at which releases from Warm Springs Dam and Coyote Valley Dam may be changed during flood control operations. The existing Water Control Manuals allow releases to be changed at up to 1,000 cfs per hour when outflows from the reservoir exceed 1,000 cfs. To protect spawning gravel and juvenile salmonids within the Russian River and Dry Creek, USACE has developed interim guidelines in consultation with NOAA Fisheries and CDFG for release changes (USACE 1998b), as summarized in Table 3-1.

Table 3-1 Ramping Rates when Flows in Mainstem Russian River Exceed 1,000 cfs

Reservoir Outflow	Ramping Rates
0-250 cfs	125 cfs/hour
250-1,000 cfs	250 cfs/hour
>1,000 cfs	1,000 cfs/hour

USACE follows the existing guidelines 90 percent of the time (P. Pugner, USACE, pers. comm., 2000). Ramping rates from 1,000 to 250 cfs/h typically occur in winter or spring as flood control operations reduce flows from much higher rates following storm events. Typically, flows in the mainstem Russian River at Ukiah exceed 1,000 cfs when flows are reduced at these rates. Ramping rates of 125 cfs/h, or less, have been used during the low-flow summer months when maintenance or inspection of Warm Springs Dam or Coyote Valley Dam requires a reduction in releases from the water supply pool.

More specific directions are included in Exhibit A of the Coyote Valley Dam water control manual, entitled "Standing Instructions to Damtenders" (Coyote Valley Dam Standing Instructions). Operation for flood control is described by the Flood Control Diagram summarized in Exhibit A:

> *Flood Control Schedules 1, 2 and 3 releases are used to empty the flood control space following a storm. Under these schedules, releases will be limited to: (1) the discharge that does not cause the flow at the Russian River near Hopland to exceed 8,000 cfs, and (2) the discharge that results in flow at Hopland being less than that reached during the previous storm or storm series. The previous storm or storm series is defined as the events, which caused the highest pool at Lake Mendocino. In addition, releases will be limited to (1) at least 2,000 cfs and up to a maximum of 4,000 cfs if the reservoir pool did not reach elevation 746.0 feet, (2) up to a maximum of 4,000 cfs if the highest reservoir pool reached was between elevation 746.0 feet and 755.0 feet, and (3) up to a maximum of 6,400 cfs if the pool exceeded elevation 755.0 feet. Releases will not be increased or decreased at a rate greater than 1,000 cfs per hour. Schedules 1, 2, and 3 are used if no significant rainfall is predicted.*
>
> *When the QPF[1] is 1 inch or more for the next 24 hours or 2 inches or more for any 6-hour period in the next 24 hours, outflow from the lake should be limited to 2,000 cfs or less to the extent possible, so that the release can be reduced to 25 cfs within 1-1/2 hours if necessary (includes 2 hours to travel to control tower and make first gate change). Also, when the flow in the Russian River at Ukiah exceeds 2,500 cfs and is rising, releases from Lake Mendocino will be reduced to 25 cfs, insofar as possible.*
>
> *Outlet gates may be used when the pool is above the spillway crest (elevation 764.8) for Flood Control Schedule 3 releases, however the sum of the spill and the releases must not exceed 6,400 cfs, subject to the above limitations.*
>
> *The Emergency Release Schedule is used when the pool elevation is above 771.0 feet. Continue to follow the Emergency Release Schedule if the pool*

[1]The Local AWIPS MOS Program (LAMP) quantitative precipitation forecast (QPF) model produces 1- to 22-hour forecasts of precipitation over the conterminous United States.

elevation is between 771.0 feet to 773.0 feet. At elevation 773 feet and above, the flood control gates are fully open. The flood control gates will remain fully open until the lake has receded below elevation 773 feet. If the pool is receding and is between elevation 773.0 feet and 771.0 feet, follow the Emergency Release Schedule. Flood Control Schedule 3 releases are made when the lake has receded below elevation 771.0 feet.

Inflows to Lake Mendocino were historically measured directly at the USGS gaging station on the East Fork Russian River, just upstream of Lake Mendocino. This station (USGS Station No. 11461500) measures the runoff from 92 of the 105 square miles of drainage area that contributes to runoff to Lake Mendocino. The USGS no longer maintains flow records for the station, but continues to collect stage data. Inflow to Lake Mendocino is currently computed from change in storage and releases.

Discharge capacity from the reservoir, with all gates open, is 5,950 cfs when the water surface elevation is at the bottom of the flood control pool (i.e., when the water surface elevation [WSE] reaches the stage when the reservoir is converted from water supply operation to flood control operation), and 6,700 cfs at full pool. Releases above this level would require use of the spillway. The design discharge capacity of the spillway is 35,800 cfs.

3.1.2.1 Previous ESA Actions on Coyote Valley Dam Flood Control Operations

To assure the safety, structural integrity, and operational adequacy of these projects, the dams are inspected periodically. Routine inspections include annual pre-flood inspections and more comprehensive 5-year periodic inspections; however, inspections and evaluations may be more frequent, if necessary. Non-routine inspections include post-earthquake inspections. For safety reasons, releases must be reduced or terminated during some portions of these inspections. Normal releases may also be reduced or modified for special testing, such as an outlet works vibration testing carried out in 1998 at Warm Springs Dam. Following formal notification by USACE to NOAA Fisheries, SCWA notifies involved regulatory agencies, including FERC and SWRCB.

USACE has entered into separate formal and informal consultations with NOAA Fisheries since 1997 to address the effects on coho salmon, Chinook salmon, and steelhead resulting from temporary flow reductions or increases from Coyote Valley Dam and Warm Springs Dam. In some cases, monitoring was conducted during the time work was scheduled to assess the potential for stranding fry and juvenile salmonids (see Section 3.1.5.2).

The temporary flow reductions and related actions conducted under previous ESA consultations are summarized as follows:

1. In July 1998, USACE submitted a BA to NOAA Fisheries to address the effects of flow reductions during periodic inspections at Coyote Valley Dam and Warm Springs Dam (USACE 1998a). On September 4, 1998, NOAA Fisheries issued a BO and incidental take statement for these activities (NMFS 1998b).

2. In May 1999, USACE submitted a BA to NOAA Fisheries to address the effects of flow reductions during pre-flood inspections at Coyote Valley Dam and Warm Springs Dam (USACE 1999a). In June 1999, NOAA Fisheries issued a BO and incidental take statement for these activities (NMFS 1999d).

3. USACE consulted with NMFS on March 17, 2000, for inspection of the outlet tunnel at Coyote Valley Dam as part of the 2000 pre-flood inspections.

   After consultation with NMFS, USACE conducted pre-flood inspections at Coyote Valley Dam on May 11, 2000. NMFS determined that the flow reduction was not likely to adversely affect federally-listed species or habitat. The terms of concurrence required ramping down in 50 cfs/hr increments. NMFS and USACE monitoring teams found that, during the ramping-down period, gravel bars became dewatered at the confluence of Ackerman Creek and the Russian River, as well as locations upstream. Stranding and mortality occurred. Since USACE did not have an incidental take statement, NMFS requested that normal operations resume. USACE immediately restored normal outflows.

   On September 22, 2000, USACE received a letter of not likely to adversely affect federally listed species or habitat for the Coyote Valley Dam reductions in flow.

4. On May 16, 2000, project operators reported abnormal noise from service gate #3 while making gate changes at Coyote Valley Dam. Flows were routed from gate #3 to gate #2 to alleviate the problem. A visual inspection of gate #3 was unsuccessful in determining the cause of the problem, requiring further investigation.

   In July 2000, USACE consulted with NMFS to reschedule the Coyote Valley Dam outlet conduit inspection and gate testing for Coyote Valley Dam.

   On October 11, 2000, USACE received a BO from NMFS for the Coyote Valley Dam inspection and gate testing.

   On October 12, 2000, after inspection of outlet conduit, USACE performed a series of tests on slide gate #3, requiring ramping up to 750 cfs to replicate the conditions under which the noises were first noted. No stranding or mortality occurred downstream.

5. On July 24, 2001, USACE consulted with NMFS for pre-flood inspection of the outlet conduit and City of Ukiah repairs to the bifurcation plate in the plenum chamber.

   On September 20, 2001, USACE received a BO from NMFS for the Coyote Valley Dam inspection and City of Ukiah work.

   On September 25, 2001, releases were stopped for 2 hours while USACE inspected the outlet tunnel. Concurrent with the USACE inspection, the City of Ukiah installed a temporary 2-foot inflatable dam within the conduit to allow the

City to work in the tunnel while releases of up to 150 cfs were made over the subsequent 4 days. Once the City's work was completed, releases were dropped to 50 cfs for 1 hour to remove the temporary dam. However, the City was not able to remove the steel plates used to keep the skirt portion of the temporary inflatable dam in place while there was appreciable flow in the tunnel. The City notified USACE of the problems encountered, and it was determined that the City would remove the steel plates during the 2002 pre-flood inspection. No mortality occurred downstream.

6. August 22, 2002, USACE consulted with NMFS for pre-flood inspection of the outlet conduit. Additionally, during the inspection, the City of Ukiah would remove the steel plates left in place from the 2001 repairs.

   On September 25, 2002, USACE received a BO from NMFS for the Coyote Valley Dam inspection.

   On September 26, 2002, releases were stopped for 2 hours while USACE inspected the outlet tunnel and the City removed the steel plates in the plenum floor. No mortality occurred downstream.

Tunnel inspections for periodic inspections in 2003 occurred on September 17 at Coyote Valley Dam, with structural inspections conducted the previous day.

3.1.3 Water Supply Operations

During water supply operations, water is released from Lake Mendocino to meet water supply demands between Lake Mendocino and Healdsburg and the required minimum flow at Healdsburg. Ordinarily, no water is released from Lake Mendocino for diversion by SCWA or any other diverters below Dry Creek. Under current demand, during a normal summer, SCWA must release close to, and occasionally exceed, 300 cfs from Lake Mendocino to allow for water supply demands above Healdsburg and still meet the 185-cfs minimum currently required by D1610 at Healdsburg. During the summer months, flow targets should be at least 10 cfs to 20 cfs above the minimum flows at Healdsburg to ensure that instream flow requirements are met regardless of fluctuating demands. Because a change in release at Lake Mendocino may take 3 days to appear at Healdsburg, changes in demand must be anticipated several days in advance.

3.1.4 Lake Mendocino Hydroelectric Power Plant

The Lake Mendocino Hydroelectric Power Plant (LMHPP), owned and operated by the City of Ukiah was completed in May 1986 at a total cost of approximately $22 million. The power plant was added as an external facility to the downstream base of Coyote Valley Dam, which was not originally designed to supply a hydroelectric plant (City of Ukiah 1981). The power plant has a total generation capacity of 3.5 MW through two generators rated at 1 MW and 2.5 MW, respectively. The City of Ukiah operates the project under a 50-year license issued April 1, 1982, by FERC (Project No. 2481-001). The City of Ukiah is a member of the Northern California Power Authority (NCPA).

NCPA owns and operates various power generation plants throughout California and provides power to their members. The City of Ukiah uses the LMHPP to supplement other power sources within the City's system and has no contractual minimum power output requirements to maintain. Power output is determined by the amount of water released from the dam for water supply, minimum instream flow requirements, and flood control, rather than power generation needs.

The hydraulic turbines require flows between 175 and 400 cfs to operate and produce electrical power. Flows below 175 cfs are not sufficient to produce power. Dam flows, which pass through the facility, are maintained at a minimum of 25 cfs.

Water flows are directed through the LMHPP from an outlet tunnel from the dam. The 959-foot-long, 12.5-foot-diameter concrete tunnel extends beneath the dam between its upstream and downstream sides. Flows exiting the facility run through a riprapped channel that merges with the East Fork Russian River approximately 700 feet downstream from the LMHPP.

The City of Ukiah has an agreement with FERC that is endorsed by CDFG and USFWS to provide between 7 and 15 cfs of water to operate the Coyote Valley Fish at Coyote Valley Dam (FERC 1983). Minimum flow rates were specified for the hatchery facility in accordance with D1610. FERC permit guidelines require the City of Ukiah to maintain DO levels downstream of the LMHPP at 7.5 mg/l at least 90 percent of the time, with a minimum requirement of 7 mg/l and a monthly median value of 10 mg/l for the year (FERC 1982). The City of Ukiah continuously monitors the DO level on a computer system. When the LMHPP turbines are in operation and the DO level approaches 7 mg/l, the turbines are shut down and the flow is diverted to the bypass valves.

Flow releases are not made for the City of Ukiah's hydroelectric plant. The plant generates power using releases made by either the USACE, for flood control purposes, or by SCWA for minimum flow releases. However, flow releases must be halted to initiate or cease hydroelectric operations. To initiate or cease hydroelectric operations, the City of Ukiah must make a request to USACE to decrease releases from the dam to 0 cfs for several hours. Halting flow releases has the potential to adversely affect listed fish in the East Fork and in the Russian River below the Forks. The lifestages affected and the severity of the effects would depend on the timing of the flow cessations.

The City of Ukiah is not currently operating the LMHPP. The City of Ukiah will develop an alternative transition procedure to eliminate the need to halt flow releases or will undergo a separate Section 7 consultation with NOAA Fisheries to address these concerns. The City of Ukiah intends to bring the power plant back into operation as soon as possible. When in operation, the LMHPP produced an annual average of 8 to 9 million kilowatt-hours of power.

3.1.5 FACTORS AFFECTING SPECIES ENVIRONMENT DUE TO OPERATIONS AT COYOTE VALLEY DAM AND LAKE MENDOCINO

3.1.5.1 Flood Control Operations

The change in hydrologic regime associated with flow regulation by dams can initiate a geomorphic response in the channel (Collier, Webb, and Schmidt 1996). The type and magnitude of adjustments depend on initial channel conditions and the extent of changes in discharge and sediment supply (Reiser and Ramey 1985). The effect of dams on the river morphology tends to diminish downstream due to discharge and sediment contributions from tributaries. Although the rate of channel change in response to flow regulation by dams is highly variable, most channel adjustments likely take place within a few decades following dam construction (Mount 1995).

Channel geomorphic changes may occur due to interruption of the sediment transport regime by dams and reservoirs. Sediments that are deposited within a reservoir will likely remove a significant portion of the total sediment load. Therefore, replenishment of sediments downstream will be reduced until there are sufficient sources of sediment input from downstream tributaries (Grant, Schmidt, and Lewis 2003). This can lead to excess stream power immediately downstream of a dam. Relatively clear water with little sediment in transport can perform more work scouring sediments from the streambed, banks, and floodplain. Thus, sediment entrainment below the reservoir may continue. Without sediment replenishment and with excess stream power, only the coarsest material may be left behind, leading to armoring of the channel bed (Mount 1995).

Adequate flows are periodically needed to maintain channel geomorphic conditions by mobilizing the streambed and transporting sediments (Trush, McBain, and Leopold 2000). Such flows are necessary to provide suitable spawning and rearing conditions for salmonids, and to flush fine sediments from the streambed and maintain bar-pool morphology. However, if flood releases are of sufficient magnitude and frequency to regularly scour redds, spawning may be adversely affected. Ideally, a balance, or dynamic equilibrium, occurs between periodic mobilization of the streambed, recruitment and transport of sediment, and sediment deposition and stability of spawning gravels. Lack of peak flows can reduce spawning gravel quality, impairing spawning success, as can an increase in the frequency and magnitude of peak flows.

On the mainstem Russian River, potential effects due to flood control operations under baseline conditions were evaluated in *Interim Report 1* (ENTRIX, Inc. 2000a). Because coho salmon do not spawn in the mainstem, effects were evaluated for steelhead and Chinook salmon only. The upper and middle reaches, between Ukiah and Alexander Valley, were included in the assessment since flood control operations at Coyote Valley Dam have little influence on the magnitude of high flows downstream of Alexander Valley.

The evaluation indicated that steelhead spawning gravels are very stable in the upper mainstem reach. The potential for scour of Chinook salmon gravels is moderate, but represents an acceptable balance between periodic streambed mobilization and spawning gravel stability. Frequent mobilization of the streambed (by bankfull discharges occurring, on average, every 1 to 2 years) and large floods (exceeding the 3- to 5-year annual maximum) are important attributes of adjustable channels that are needed to maintain a balanced sediment budget over the long-term (McBain and Trush 1997). The lower incidence of scour of steelhead gravels compared with Chinook salmon gravels is partially due to the later steelhead incubation period. The occurrence of flows in the Upper Reach that might scour spawning gravels later in the season when steelhead are incubating is fairly low.

In the Middle Reach of the Russian River at Alexander Valley, spawning gravels are less stable and subject to slightly more frequent scour than in the Upper Reach. The evaluation indicates moderately stable conditions for Chinook salmon, and slightly less stable conditions for steelhead. Higher discharges due to tributary flow accretion might account for the greater incidence of scour in the Middle Reach compared with the Upper Reach. Flood control operations do not have a significant effect on peak flows and spawning gravel scour in the Middle Reach (see Section 3.1.1 for discussion of Coyote Valley Dam effect on peak flows).

The potential for bank erosion was evaluated for the upper and middle reaches of the Russian River in *Interim Report 1* (ENTRIX, Inc. 2000a). On the mainstem Russian River, 6,000 cfs at Hopland in the Upper Reach and 8,000 cfs at Cloverdale in the Middle Reach were identified as the flow thresholds at which bank erosion is likely to begin. These flow thresholds for erosion are based on a comparison of unregulated flood recurrence intervals with Dry Creek. On Dry Creek, reported observations of bank erosion indicate that high flows greater than 2,500 cfs, which correspond to the 1.1-year average 1-day unregulated flood event, initiate erosion. There are no specific flow thresholds for which bank erosion has been observed or reported on the Russian River. Therefore, similar to Dry Creek, it was assumed that the 1.1-year flood event would be the threshold at which bank erosion is initiated. For the unregulated Russian River, the 1.1-year 1-day flood interval was determined to be 6,000 cfs at Hopland and 8,000 cfs at Cloverdale.

The analysis indicates that prolonged flows above these thresholds are relatively infrequent. At Hopland, flows never exceeded 6,000 cfs for more than 3 days in any given year (i.e., occurred less than 1 percent of the time) for each of 20 years analyzed over the 36-year period-of-record, and the risk of bank erosion in those years is relatively low. Over an additional 6 years, flows did not exceed 6,000 cfs for more than 7 days in each year (i.e., less than 2 percent of the time in any given year). There were 3 years in which flows did not exceed 6,000 cfs for more than 11 days per year (i.e., less than 3 percent of the time in any given year), which results in a moderate risk of bank erosion. There were 7 years (19 percent) in which flows exceed 6,000 cfs for 12 or more days, resulting in a high risk of bank erosion.

At Cloverdale, flows never exceeded 8,000 cfs for more than 3 days in any given year (i.e., occurred less than 1 percent of the time) for each of the 18 years analyzed over the 36-year period-of-record. Over an additional 7 years, flows did not exceed 6,000 cfs for more than 7 days in each year (i.e., less than 2 percent of the time in any given year).

There were 2 years in which flows did not exceed 6,000 cfs for more than 11 days per year (i.e., less than 3 percent of the time in any given year), and there is consequently a moderate risk of bank erosion in those years. There were 9 years (25 percent) in which flows exceed 6,000 cfs for 12 or more days, resulting in a high risk of bank erosion.

On many of the days when flows exceeded the erosion threshold at either location, discharge from Coyote Valley Dam was low. This is because flood control operations are timed so that reservoir outflows are a relatively insignificant contributor to the total flow during most runoff events to minimize flooding. This is a basic function of flood control reservoirs. Review of the runoff record indicates that, for 78 out of 91 days in the 36-year period analyzed, Coyote Valley Dam operations did not contribute to the flows exceeding the bank erosion threshold at Hopland. There were 87 days out of a total 97 days in the 36-year period of record analyzed when Coyote Valley Dam did not contribute to exceeding the bank erosion threshold at Cloverdale. This indicates that flows exceeding the erosion threshold are most often due to natural runoff conditions, rather than the timing of releases from Coyote Valley Dam. This also indicates that flood control operations at Coyote Valley Dam do not cause prolonged flows above the threshold that initiate streambank instability and erosion.

Flood control operations have a minimal effect on channel maintenance/morphologic conditions on the mainstem. The channel-forming discharge was identified by calculating the 1.5-year annual, 1-day maximum flood in the Upper Reach as 9,500 cfs at Hopland, and in the Middle Reach as 14,000 cfs at Cloverdale and 21,000 cfs at Healdsburg. *Interim Report 1* evaluated flood control operations (ENTRIX, Inc. 2000a). The evaluation indicated that the natural channel maintenance occurs only slightly less often than the estimated expected frequency of one event every 2 out of 3 years (Dunne and Leopold 1978).

On the mainstem Russian River, effects of flow ramping during flood control operations were evaluated from approximately 3 to 5 miles below Coyote Valley Dam, using hydrologic modeling at four cross sections in this reach (no cross sections are available closer than 3 miles from the dam) (ENTRIX, Inc. 2000a). A stage-change of 0.16 feet per hour (ft/hr) or less was used as a conservative criterion for protection of juvenile fish.

At Coyote Valley Dam, the results of hydraulic modeling indicate that all of the four cross sections in the upper Russian River exceed the 0.16 ft/hr and the 0.32 ft/hr criterion at 250 cfs/hr ramping rates (ENTRIX, Inc. 2001d). Change in stage was generally 0.5 ft/hr or more when ramping at 250-cfs/hr increments. However, Coyote Valley Dam is usually operated within the 250 cfs/hr interim ramping rate only when reservoir outflows are 1,000 to 250 cfs. Under these conditions, the risk of stranding due to dewatering is lower. The forks usually have considerable flow from the mainstem Russian River to attenuate ramping effects. Often flows are greater than 2,500 cfs at the forks during flood operations ramp-down, and there is a backwater effect on the East Fork which would attenuate stage-changes (P. Pugner, USACE, pers. comm., 2000). Results were similar for stage-changes associated with 125-cfs/hr flow reductions when reservoir release flows were 250 to 0 cfs. Therefore, ramping rates associated with flood control operations provide adequate protection to listed fish species.

3.1.5.2 Dam Maintenance and Inspection

During Coyote Valley Dam maintenance and inspections, flows are typically ramped down at a rate of 50 cfs per hour until releases cease. Recent historical effects of ramping on the East Fork and mainstem Russian River were evaluated regarding incidences of stranding. Based on this evaluation, the 50 cfs per hour ramping rate does not provide adequate protection from stranding for fry or juveniles of steelhead or Chinook salmon. (Coho salmon do not rear in the Upper Reach of the mainstem Russian River and were not evaluated.)

Coyote Valley Dam inspections and maintenance during September 1998 resulted in dewatering stream segments in the East Fork and farther downstream on the mainstem, creating the need to rescue juvenile steelhead. However, during inspection and maintenance in June 1999, no stranding was documented and fish rescue was unnecessary, as pools were maintained on the East Fork to provide refuge (T. Marks, USACE, pers. comm., 2000). Gage records indicate that flow downstream of the forks near Ukiah on the mainstem was at least 14 cfs during the inspection and maintenance activities. The presence of pools and lack of stranding may have been partially due to the maintenance of instream flows on the East Fork that was derived from dewatering of the stilling basin. The stilling basin provided approximately 1 to 4 cfs to the East Fork for several hours following cessation of releases from the dam. However, flow accretion from seepage or groundwater contributions are also responsible for maintaining pools and minimal streamflow on the East Fork. Over the past 6 years, approximately 5 to 6 cfs has been measured at the weir below Coyote Valley Dam during maintenance inspections after flow releases have ceased (USACE 2003a). This 5-to 6-cfs flow is assumed to be derived from either seepage around the dam or from groundwater contribution to the East Fork. No mortalities have been recorded when inspection and maintenance activities have been scheduled to take place in the late summer/fall season (September) over the past 5 years (USACE 2003a).

3.2 WARM SPRINGS DAM AND LAKE SONOMA

3.2.1 LAKE SONOMA

Lake Sonoma is a multipurpose reservoir. It provides flood protection to areas downstream; provides water for domestic, municipal, and industrial uses; and is operated for hydroelectric power production (see Figure 2-1). Lake Sonoma collects runoff from a drainage of approximately 130 square miles.

Lake Sonoma has a gross capacity of 381,000 AF at the spillway crest elevation of 495 feet above MSL. Lake Sonoma has a 130,000-AF flood control storage capacity, which is sufficient to collect runoff from a 100-year, 6-day flood event. The conservation pool has a 245,000-AF design capacity. SCWA has a water rights permit authorizing storage of 245,000-AF of water in Lake Sonoma. As with Lake Mendocino, SCWA determines the water release rate from the water supply pool in Lake Sonoma in accordance with its state water rights permits. USACE determines releases when the water level rises above the top of the water supply pool (El. 451.1 feet above MSL) and into the flood control pool.

USACE determines releases during inspections, maintenance, and repairs scheduled outside the flood control season. Following formal USACE notification, SCWA notifies affected regulatory agencies, including FERC and SWRCB, of these lower releases. USACE notifies and consults with NOAA Fisheries.

The Warm Springs Dam and Lake Sonoma Project are operated using the *Warm Springs Dam and Lake Sonoma, Dry Creek, California Water Control Manual* (USACE 1984). Objectives described in this document include: (1) provide the maximum reduction in peak-flood discharges on Dry Creek and the Russian River below Healdsburg; (2) provide the maximum practical amount of conservation storage without impairment to other project functions; and (3) maintain a minimum pool elevation of 292 feet above MSL to assure operation of the fish hatchery. The 130,000 AF of flood control storage in Lake Sonoma was designed to provide control of a flood the size of the December 1955 flood event, which had a peak discharge of approximately 26,000 cfs at the dam site and represents about a 20-year flood event.

USACE requires that a minimum fishery pool be maintained in Lake Sonoma at an elevation of 292 feet above MSL (USACE 1998b). At this minimum pool, the reservoir has a storage volume of 20,000 AF, a surface area of 415 acres, extends approximately 5 miles up Dry Creek and 2 miles up Warm Springs Creek, and has 17 miles of shoreline (USACE 1998b).

Water supply releases from Lake Sonoma are used to meet minimum instream flows and municipal, domestic, and industrial demands in the lower Russian River area and portions of Sonoma and Marin counties (USACE 1998b). To meet these demands, water released from Lake Sonoma combines with releases from Coyote Valley Dam and runoff from other tributaries. Inflow to Lake Sonoma approaches 0 from July through September, and the reservoir normally reaches its lowest level in November.

3.2.2 Flood Control Operations of Warm Springs Dam

USACE's primary objective for flood control operation at Warm Springs Dam is to reduce peak flood discharges in Dry Creek and the Russian River below Healdsburg to the extent possible. Because of the long travel time for water flow between Coyote Valley Dam and the Russian River/Dry Creek confluence, flood control operations at Warm Springs Dam are generally independent of the Coyote Valley Dam operation; however, operations of the two facilities are coordinated to avoid downstream flooding.

The criteria for flood control operation of Lake Sonoma are similar to those for Lake Mendocino, and are described in the Warm Springs Dam Water Control Manual (USACE 1998b). As with Lake Mendocino, flood control includes three successive flood release schedules. For Lake Sonoma, the Hacienda gage near Guerneville, located 16 miles downstream of Warm Springs Dam, is the most downstream monitoring point for decisions affecting flood control releases from Lake Sonoma.

To the extent possible, USACE manages releases from Lake Sonoma to limit flows on the Russian River at Guerneville to 35,000 cfs, which is the approximate channel capacity in Guerneville. USACE also limits releases to prevent flooding downstream along Dry Creek, which generally occurs when flows just below the dam exceed 6,000 cfs. As with releases from Lake Mendocino, USACE limits changes in releases to 1,000 cfs per hour to prevent downstream bank sloughing.

More specific directions are included in Exhibit A to the Warm Springs Dam Water Control Manual (USACE 1998b), entitled "Standing Instructions to Damtenders" (Warm Springs Dam Standing Instructions). Operation for flood control is described in the Flood Control Diagram that is summarized by Section 9b:

> *Flood Control Schedule 1, 2, and 3 releases are used to empty the flood control space following a storm. Under these schedules, releases will be limited to: (1) the discharge that does not cause the flow in the Russian River near Guerneville to exceed 35,000 cfs, and (2) the discharge that results in flow at Guerneville being less than that reached during the previous storm or storm series. The previous storm or storm series is defined as the event(s), which caused the highest pool at Lake Sonoma. In addition, releases will be limited to a maximum of: (1) 2,000 cfs if the reservoir pool did not reach elevation 456.7 feet, (2) 4,000 cfs if the highest reservoir pool reached was between elevation 456.7 feet and 468.9 feet, and (3) 6,000 cfs if the pool exceeded elevation 468.9 feet. Releases will not be increased or decreased at a rate greater than 1,000 cfs per hour. When the pool elevation is at or below 502.0 feet and inflow is at or above 5,000 cfs no gate releases will be made. Schedules 1, 2, and 3 are used only if no significant rainfall is forecasted.*
>
> *Significant rain is forecasted when the QPF is 1 inch or more for the next 24 hours or ½ inch or more for any 6-hour period in the next 24 hours. Under this condition, outflow from the lake should be limited to 2,000 cfs or less to the extent possible, so that the release can be reduced to the minimum required flow within 1½ hours if necessary. The 1½ hours includes time to travel to the control tower and make the first gate change.*
>
> *Flood Control Schedule 3 releases will be maintained until elevation 502.0 feet is reached by regulation of the outlet so that the combined flow from spills (pool above elevation 495.0 feet) and releases through the outlet works does not exceed 6,000 cfs.*
>
> *The Emergency Release Schedule is used when the pool elevation is between 502.0 feet to 505.0 feet. At elevation 505 feet and above, the flood control gates will be fully opened. The flood control gates will remain fully open until the lake has receded below elevation 505 feet, at which time the Emergency Release Schedule is again implemented. When the lake has receded below elevation 502.0 feet, Flood Control Schedule 3 is implemented.*

Because of the watershed's configuration above Lake Sonoma, direct measurement of reservoir inflow by stream gaging is impractical. Consequently, inflow is calculated as the algebraic sum of releases, changes in storage, and estimated evaporation.

Water is released from Warm Springs Dam for flood control purposes through the outlet works or through the spillway, which are located on the left abutment of the dam. The control structure accommodates multiple intakes that can be used to meet water quality requirements, as described in Section 3.2.3. Maximum discharge capacity of the outlet works is 8,100 cfs when the reservoir pool is at 513.1 feet above MSL. The spillway was designed for a discharge of 29,600 cfs, with the maximum reservoir pool elevation being 18 feet above the spillway crest.

3.2.2.1 Previous ESA Actions on Warm Springs Dam Flood Control Operations

USACE has entered into separate formal and informal consultations with NOAA Fisheries since 1997 to address the effects on coho salmon, Chinook salmon and steelhead resulting from temporary flow reductions or increases from Warm Springs Dam. In some cases, monitoring was conducted during the time work was scheduled to assess the potential for stranding fry and juvenile salmonids (see Section 3.1.2).

The temporary flow reductions and related actions conducted under previous ESA consultations are summarized as follows:

1. In July 1997, USACE provided NOAA Fisheries with a BA and requested a formal consultation under ESA Section 7 to address the effects of flow reductions resulting from proposed repair work on the Emergency Water Supply Line (EWSL) at Warm Springs Dam and the annual pre-flood inspection at Warm Springs Dam. The EWSL, which supplies water from the Warm Springs Dam outlet works to the DCFH located at the base of Warm Springs Dam,[2] was damaged during high flood releases during a flood event in January 1997. On September 30, 1997, NOAA Fisheries issued a BO and incidental take statement for these activities.

   In November 1997, USACE submitted a supplement to its July 1997 BA to NOAA Fisheries to address a vibration analysis test on the Warm Springs Dam outlet works (USACE 1997). The test, which was intended to determine the cause of damage to the EWSL and outlet works during the January 1997 event, required varying releases from below 50 cfs to over 3,000 cfs over a 2-day period. The consultation was requested under 50 Code of Federal Regulations (CFR) Sec. 402.05 (Emergencies), which provides that:

   (a) Where emergency circumstances mandate the need to consult in an expedited manner, consultation may be conducted informally through alternative procedures that the Director of the National Marine

[2]Operation of the hatchery is described in detail in *Interim Report 2* (Fish Facility Operations) (FishPro and ENTRIX, Inc. 2000).

Fisheries Service determines to be consistent with the requirements of sections 7(a)-(d) of the Endangered Species Act. This provision applies to situations involving acts of God, disasters, casualties, national defense or security emergencies, etc.

Due to dam safety concerns relating to the reliability of the outlet works, USACE proceeded with the testing in January and February of 1998. Additional tests were carried out in March 1998. A BO was not issued to USACE for these tests. NOAA Fisheries protested the additional tests performed by USACE in March 1998 that were needed to complete the analysis of the vibration phenomena on the EWSL.

2. In July 1998, USACE submitted a BA to NOAA Fisheries to address the effects of flow reductions during periodic inspections at Warm Springs Dam and Coyote Valley Dam (USACE 1998a). On September 4, 1998, NOAA Fisheries issued a BO and incidental take statement for these activities (NMFS 1998b).

3. In May 1999, USACE submitted a BA to NOAA Fisheries to address the effects of flow reductions during pre-flood inspections at Warm Springs Dam and Coyote Valley Dam (USACE 1999a). In June 1999, NOAA Fisheries issued a BO and incidental take statement for these activities (NMFS 1999d).

4. In February 2000, USACE consulted with NOAA Fisheries for emergency repairs to the EWSL at Warm Springs Dam.

   On February 17, 2000, the EWSL at Warm Springs Dam sustained damages during high flood releases of up to 4,000 cfs. Damages to the EWSL consisted of a broken support bracket, which is used to attach the water line to the side of the stilling basin. Due to a significant pressure drop in the fill line observed by project staff during the high releases, there was concern that the EWSL within the outlet tunnel may have sustained damage. On February 23, 2000, NOAA Fisheries issued a letter of concurrence with the proposed action, concluding that the flow reduction was not likely to adversely affect federally-listed species or habitat. The terms of concurrence required ramping down/up to be done in 50-to 75-cfs/hr increments and monitoring of Dry Creek.

   An inspection of the EWSL within the main tunnel and repairs to the broken support bracket were scheduled for February 25, 2000. The inspection required that the releases through the outlet tunnel be halted for 2 hours. The EWSL was used to supply approximately 28 cfs to the fish hatchery and Dry Creek below the dam. During the reduced flow period, the bracket was repaired and the EWSL within the tunnel appeared not to have sustained any damage during the high releases.

5. On March 17, 2000, USACE consulted with NMFS to inspect the outlet tunnel and perform repairs to the EWSL at Warm Springs Dam as part of the 2000 pre-flood inspections.

On May 23, 2000, repairs to the EWSL at Warm Springs Dam and inspection of the conduit required a reduction in releases to 25 cfs for 4 days. Releases were made alternately via the conduit and the EWSL.

On September 22, 2000, USACE received a letter of not likely to adversely affect federally-listed species or habitat for the Warm Springs Dam reductions in flow.

6. In July 2000, USACE consulted with NMFS for sonic meter installation at Warm Springs Dam.

   On September 22, 2000, USACE received a letter of not likely to adversely affect federally-listed species or habitat for the Warm Springs Dam reduction flow.

   Starting on October 2, 2000, for a period of 5 days, sonic meters were to be installed in the conduit at Warm Springs Dam, requiring a reduction in outflow. No stranding or mortality occurred downstream.

7. On July 11, 2001, USACE consulted with NMFS for pre-flood inspection of the outlet conduit and repairs to the outlet conduit at Warm Springs Dam.

   On August 27, USACE received a letter of not likely to adversely affect federally-listed species or habitat for the Warm Springs Dam reduction in flow. During the week of September 10, 2001, outflow from the dam was reduced to 25 cfs for 5 days to complete the repairs and inspection. No stranding or mortality occurred downstream.

8. On March 28, 2002, USACE consulted with NMFS for pre-flood inspection of the outlet conduit at Warm Springs Dam.

   On August 14, USACE received a letter of not likely to adversely affect federally listed species or habitat for the Warm Springs Dam reduction in flow.

   On September 25, 2002, outflow from the dam was reduced to 25 cfs for 2 hours for the inspection. No stranding or mortality occurred downstream.

Tunnel inspections for periodic inspections in 2003 occurred on September 25 at Warm Springs Dam, with structural inspections conducted the previous day.

3.2.3 Water Supply Operations

In the summer, SCWA releases water from Lake Sonoma for rediversion by the SCWA water transmission system, and to meet D1610 instream flow requirements. Flow regulation in Dry Creek and the lower Russian River is described in Section 3.3.

The quality of water released from Warm Springs Dam is managed for its use in the DCFH. This water passes through the hydroelectric facility before it reaches the hatchery. *Interim Report 2: Fish Facility Operations* (FishPro and ENTRIX, Inc. 2000) has additional information on historic water use of the DCFH. Water quality (including turbidity, suspended sediment concentrations, temperature, and DO) has been monitored at DCFH twice each month for as long as its operation.

The water quality of the dam outflow, including temperature, DO, and turbidity, is managed by mixing water from the low-flow tunnels that draw water from different levels of Lake Sonoma. USACE, in coordination with CDFG, determines the selection of water intake levels from Warm Springs Dam to meet the DCFH's water quality needs. This procedure also affects the water quality of releases to Dry Creek. Before 2002, the portal nearest to the lake's surface was out of service and could not be used. USACE data for dam outlet temperatures for Warm Springs Dam from January through November 1999 demonstrate that the ability to draw water from cooler depths of Lake Sonoma keep the outlet temperatures cool during summer months.

Seasonal temperature requirements for water delivered to the DFCH range from 52°F to 55°F (11.1° C to 12.8° C) from October through April, and 55°F to 58°F (12.7°C to 14.4°C) from May to September. It is estimated that, only during a year of maximum drawdown, or once in 50 years, will the reservoir be unable to provide water that meets hatchery temperature requirements (USACE 1998b).

3.2.4 Warm Springs Dam Hydroelectric Facility

SCWA owns and operates the Warm Springs Dam hydroelectric facility. The hydroelectric facility was completed in December 1988 at a total cost of $5 million. SCWA operates the facility under a 50-year license issued by FERC on December 18, 1984 (Project No. 3351-002). The 3,000-KW Francis turbine generator has a power rating of 2.6 MW (USACE 1984). The facility is located within the control structure of the outlet works for Warm Springs Dam.

Water from Lake Sonoma flows to the hydraulic turbine via a vertical wet well located in the control structure that draws water from the horizontal, low-flow tunnels. The upper tunnel was non-operational, but was repaired in 2002. Water from the tunnels drops between 132 and 221 feet to the turbine. Water passing through the turbine flows into the flood control tunnel to a stilling basin located at the base of the dam. A 20-inch emergency water supply line installed inside the conduit provides water to the hatchery in the event of a gate failure. This bypass line is engineered to divert water through the hatchery and to Dry Creek at a maximum flow capacity of approximately 25 cfs.

From the stilling basin, water flows through a channelized portion of Dry Creek, or is diverted for use in the DCFH adjacent to Warm Springs Dam. The stilling basin is a concrete-lined basin at the mouth of the outlet tunnel. A two-step weir, approximately 18 feet high, is used to reduce the water velocity from the outlet tunnel and to keep fish downstream of the dam from entering the outlet tunnel.

The hydroelectric facility operates during normal releases of water through the low-flow tunnels and the wet well. A minimum flow of approximately 70 cfs is needed to operate the turbine. The maximum flow capacity for the turbine is approximately 185 cfs. During flood control operations (when releases from Warm Springs Dam exceed 3,000 cfs), flow through the wet well and turbine are shut off to prevent hydraulically unstable conditions from developing in the outlet piping. When water releases of more than 500 cfs are required, service gates in the left abutment of the intake conduit are opened, and flows bypass the wet well and turbine. The minimum opening allowed for the service gates is 1 foot, which relates to a release of 500 cfs. Also, flows of 185 cfs through the turbine can continue, with the remaining flow bypassed through the service gates. However, the total flow through the wet well and the service gate must be less than 3,000 cfs.

Flows through the hydroelectric facility are determined by water supply needs and minimum instream flow requirements. The turbines can operate at flows of 70 to 185 cfs. The water supply needs and minimum instream flow requirements set by D1610 (SWRCB 1986a) generally provide flows sufficient for hydroelectric power generation, and the plant operates on flows releases for other purposes. No flow releases are made solely for the benefits of hydroelectric generation.

The Russian River system model, developed by SCWA, models flow in the Russian River basin based on minimum streamflow requirements (under D1610) and water supply demands (Flugum 1996). The model calculates the amount of power generated at model flows. Table 3-2 shows the power generated at model flows for June, July, and August of 1988 through 1995. These years encompass both *normal* and *dry* water supply conditions. All of the modeled power values exceed the minimum 1.246 MW required for SCWA to receive capacity payments under its power sale agreement with PG&E. Because releases needed to generate the minimum power requirement are lower than releases made for D1610 and water supply demands, hydroelectric operations do not control releases from Warm Springs Dam.

Table 3-2 Power Generated at Russian River Model Flows under Decision 1610

Water Year	Power (MW)
1988	2.427
1989	2.750
1990	1.382
1991	1.594
1992	4.129
1993	3.437
1994	1.606
1995	3.721

Articles 33 and 34 of SCWA's FERC license (FERC 1984) contain minimum release provisions for Warm Springs Dam that are identical to the D1610 minimum flows.[3] CDFG recommended that Lake Sonoma water level fluctuations be minimized during the

[3] Details on water supply and minimum streamflow needs are addressed in *Interim Report 3: Flow-Related Habitat* and *Interim Report 4: Water Supply and Diversion Facilities* (ENTRIX, Inc. 2002b, 2001d).

spawning period for warmwater fishes to no more than 2 feet per month. Therefore, Article 34 also specifies that SCWA "…shall for the protection of fish spawning in Lake Sonoma, operate the Warm Springs Project such that the water surface elevation of Lake Sonoma fluctuates no more than 2 vertical feet between April 1 and June 15 of each year" (FERC 1984).

The wording of Article 34 initially presented some uncertainty as to how the Warm Springs Dam hydroelectric facility was to be operated under the license. This is because other operating requirements, such as D1610 minimum streamflows and USACE flood control release criteria (USACE 1984, 1986a), require changing the surface elevation of Lake Sonoma by more than 2 vertical feet between April 1 and June 15. During the license application process, SCWA and CDFG agreed that water should not be released solely for electrical power production purposes when such releases would contribute to or cause surface fluctuations in Lake Sonoma to exceed 2 vertical feet per month between April 1 and June 15. The recitals in FERC's 1984 order stated FERC's intention to incorporate this agreement into the license without modification. SCWA's interpretation of Article 34 is that surface water fluctuations resulting from releases solely for the purpose of power production between April 1 and June 15 are limited to 2 vertical feet per month, as agreed by SCWA and CDFG, and as intended in the FERC order. In a letter dated June 2, 1989, SCWA notified FERC of its interpretation. FERC has taken no exception to this interpretation.

Because intakes to the Warm Springs Dam hydroelectric facilities are not screened, resident salmonids from Lake Sonoma could pass through the tunnels and into the turbines. Although the exact number of fish passing through the Warm Springs Dam hydroelectric facility's turbine is not known, it is expected that mortality occurs to fish passing through the turbine due to injuries either from mechanical blows or excessive pressure.

No instream work is necessary to maintain the Warm Springs Dam hydroelectric facility. All maintenance activities occur within the Warm Springs Dam control structure shaft. During any unplanned events that require shutting down the generator, automatic controls shut down flows to the turbine and open a valve that bypasses flows around the turbine unit.

3.2.5 Factors Affecting Species Environment Due to Operations at Warm Springs Dam and Lake Sonoma

3.2.5.1 Flood Control

As discussed for flood control activities at Coyote Valley Dam in Section 3.1.5.1, the change in hydrologic regime associated with flow regulation by dams can initiate a geomorphic response in the channel. Ideally, a balance, or dynamic equilibrium, occurs between periodic mobilization of the streambed, recruitment and transport of sediment, and sediment deposition and stability of spawning gravels. When flow regulation reduces the magnitude of peak-flood discharges, river channels typically modify their cross-sections by narrowing due to sediment deposition and encroachment of riparian vegetation. When the bed material consists of a sand and gravel mixture, as on Dry Creek, channel incision will often accompany channel narrowing if the flood peaks are of sufficient magnitude to mobilize most of the bed materials. Excessive channel incision often results in oversteepened streambanks and subsequent bank erosion, causing channel widening. If flood peaks are sufficiently reduced under flow regulation, the coarser bed material will not be entrained and only finer material will be transported, leading to an overall coarsening of the channel bed.

On Dry Creek downstream of Warm Springs Dam, historical aerial photographs show that the riparian vegetation has extensively encroached, causing the channel to narrow, and probably fostering channel incision. In lower Dry Creek, incision has resulted in bank erosion and a widening of the channel. When USACE constructed Warm Springs Dam, grade stabilization structures were designed and installed, in part to offset the anticipated potential effects of the dam construction, and in part to halt channel incision related to gravel mining activity in lower Dry Creek and the Russian River. The channel downstream of Warm Springs Dam has adjusted to flow regulation, gravel mining, and other land-use activities in the watershed, and is continuing to adjust, seeking a new equilibrium. With a narrower, incised, and encroached channel, the pre-dam channel-forming flows may not be appropriate for Dry Creek in its new configuration.

The alteration of the flow regime associated with dams is not the only cause of changes in channel morphology. Development in the Russian River watershed, including gravel extraction, agricultural practices, and urbanization, also influence channel geomorphic conditions. Land uses that significantly increase or decrease sediment supply (e.g., gravel mining) will cause as much alteration in channel geomorphology as flood regulation by dams. Distinguishing the effects of flood control operations from these land use effects on channel conditions can be problematic.

Significant channel geomorphic changes were apparently underway on Dry Creek before the construction of Warm Springs Dam. A study conducted by USACE concluded that gravel mining on Dry Creek and on the mainstem Russian River had caused approximately 10 feet of incision along the 14-mile channel length by the mid-1970s (USACE 1987). The channel incision on Dry Creek initiated lateral instability and subsequent bank erosion so that channel width had increased from approximately 90 feet to over 450 feet in some locations in the 1970s (USACE 1987). The 1987 study concluded that further channel degradation was unlikely, but that continued lateral instability and erosion of the incised channel banks was likely.

Flows in Dry Creek are still sufficiently high to mobilize the streambed and thus avoid the adverse effects of sedimentation. In addition, high flow can result in bank erosion, which recruits sediment to the channel. Currently, there is a concern that high flows (above 2,500 cfs) cause bank erosion. This concern was evaluated in *Interim Report 1* (ENTRIX, Inc. 2000a). The conclusion was that, in most years, the potential for bank erosion is relatively low and flood operations at Warm Springs Dam do not significantly contribute to prolonged flows above the threshold that initiates streambank instability and erosion.

Streambed scour during winter is still a concern relative to high flows in Dry Creek. The analysis in *Interim Report 1* (ENTRIX, Inc. 2000a) found that redds for all three species could have been lost in some years. Coho salmon were the most vulnerable to redd scour because they spawn earliest during the runoff season and have more exposure to high flows. Another contributing factor is the smaller-size gravel preferred by coho salmon for spawning. The smaller coho salmon gravels are mobilized at lower flow than suitable spawning substrate for Chinook salmon or steelhead. Coho salmon redds were predicted to scour approximately 60 percent of the time, steelhead redds only 14 percent of the time, and Chinook salmon redds 28 percent of the time (ENTRIX, Inc. 2000a). Although flow releases from Warm Springs Dam can be sufficiently high to scour redds, natural peak winter runoff on Dry Creek from tributaries downstream of the unregulated Pena Creek confluence (approximately 3 miles downstream from the dam) are also the cause of at least some spawning habitat scour. During peak runoff periods, the flow records indicate that, on some days when releases from Warm Springs Dam are relatively low (less than 200 cfs), but natural peak flows downstream of the Pena Creek confluence are much greater (over 1,000 cfs). Flood control operations are often timed so that reservoir outflows during prolonged peak streamflow conditions downstream are a relatively insignificant contributor to total flow. Therefore, flood control operations are not always solely responsible for exceeding the initiation of motion threshold of spawning-size gravel.

To preserve a healthy geomorphic condition, mobilization of the bed or scour is important. The streambed should be periodically entrained to flush and transport fine sediments, thereby maintaining good-quality spawning gravels. Except for coho salmon, the results above indicate a reasonably effective balance between streambed-mobilization and spawning gravel stability for successful reproduction. Coho salmon habitat is scoured too frequently (below the Pena Creek confluence) under current conditions to provide for good reproduction opportunities in Dry Creek.

3.2.5.2 Stranding/Ramping

Annual and periodic pre-flood inspections are performed at Warm Springs Dam. Flows may be reduced in order to perform periodic maintenance activities on the dam. Since there is a bypass flow capability at Warm Springs Dam, stream dewatering is unlikely and has not occurred under recent operational practices. The bypass streamflow is generally between 25 and 28 cfs. Ramping during pre-flood inspection and maintenance activities using a 25-cfs/hr ramping rate provides adequate protection against stranding of listed species in Dry Creek.

3.3 WATER SUPPLY AND DIVERSION OPERATIONS

3.3.1 WATER SUPPLY OPERATIONS

SCWA is the wholesale provider of potable water for approximately 570,000 people in Sonoma and Marin counties. Since its creation in 1949, SCWA's role as a water supplier has evolved into two primary responsibilities:

Operation of the Russian River Project: As the local sponsor for the two federal water supply/flood control reservoir projects in the Russian River watershed (Coyote Valley Dam/Lake Mendocino and Warm Springs Dam/Lake Sonoma), SCWA, under operational agreements with the USACE, manages the water supply storage space in these reservoirs to maintain the water supply yield of the system and to maintain SWRCB-required minimum flows in the Russian River and Dry Creek. SCWA holds water rights permits to divert Russian River and Dry Creek flows and redivert water stored and released from the Lake Mendocino and Lake Sonoma.

Among the provisions contained in SCWA's water-right permits are terms authorizing maximum rates of direct diversion and re-diversion. The proportions of water diverted and re-diverted in any water year vary somewhat and depend on the amount of runoff and water demand.

Operation of the water transmission system: Downstream of Lake Mendocino and Lake Sonoma, SCWA diverts and delivers water to its wholesale customers through its water transmission system. This system consists of diversion facilities, treatment facilities, pipelines, water storage tanks, booster pump stations, and groundwater wells.

SCWA is responsible for the operation of the water transmission system through an existing water supply agreement between SCWA and eight cities and water districts in Sonoma County and northern Marin County (see Section 1.4.8), collectively referred to as the water contractors. This agreement, titled "Eleventh Amended Agreement for Water Supply" (SCWA 2001a), executed in 2001, provides for the finance, construction, and operation of diversion facilities, transmission lines, storage tanks, booster pumps, conventional wells, and appurtenant facilities. Presently, these existing facilities can meet peak deliveries at an average monthly rate of 84 mgd (which will increase to 92 mgd once Collector No. 6, currently under construction, is completed). If all of the facilities[4] contemplated by the Eleventh Amended Agreement were constructed, they would be able to meet peak-month deliveries at an average rate of 149 mgd. In addition, the Eleventh Amended Agreement contemplates that SCWA will provide 20 mgd of pump and collector standby capacity, which would allow SCWA to meet authorized water deliveries during periods when the existing diversion facilities are out of service (i.e., routine maintenance, equipment failure, system failures caused by earthquakes, floods, power outages, or other emergencies).

In addition to the Eleventh Amended Agreement, SCWA has agreements with the City of Healdsburg, the Town of Windsor, the Russian River County Water District, Camp Meeker Recreation and Park District, and the Occidental Community Services District allowing those entities to divert water from the Russian River under SCWA's water

[4] As noted in Section 1, SCWA must complete a supplemental environmental review of the program-level impacts of the WSTSP and SCWA's Board of Directors must consider the impacts identified when determining whether to approve the WSTSP (including the construction of facilities).

rights. The analysis presented in *Interim Report 4* addresses the effects on listed fish species of operation of the water supply and transmission system under existing water rights held by SCWA (ENTRIX, Inc. 2001d). The following discussion summarized and supplements the effects analysis in *Interim Report 4*.

3.3.2 WATER DEMANDS

3.3.2.1 Historical Influences

The USACE survey report prepared before the construction of Coyote Valley Dam concluded that the ultimate consumptive use requirement for irrigation in the Russian River Valley within Sonoma County was 16,000 AF. In 1961, the SWRCB determined that sufficient water (not to exceed 10,000 AF) from the Russian River Valley within Sonoma County should be reserved for use in the appropriative water rights permit issued to SCWA to meet its future requirements for 10 years. After 10 years, any water not contracted would be made available for use elsewhere. In 1974, the SWRCB amended this permit. Amendments included elimination of the 10-year time limit, and allowing individuals to file applications with the SWRCB to appropriate water from the 10,000-AF reservation for agriculture and domestic purposes.

3.3.2.2 Current Demand Level

SCWA water-right permits are described in Section 1.4.3. Currently, SCWA is permitted to divert water to storage at Lake Mendocino and Lake Sonoma and to divert and redivert water from the Russian River at the Wohler and Mirabel pumping facilities. In water year 2001/2002, SCWA diverted and rediverted approximately 65,000 AF of water from the Russian River, including both SCWA diversions and water diverted under SCWA water rights. The total amount of water that may be diverted and rediverted under SCWA permits is 75,000 AFY, at a maximum rate of 180 cfs.

It is estimated that there are presently over 600 diversions by various entities along the mainstem of the Russian River and approximately 800 other diversions along the tributaries of the Russian River (SCWA 1996b). The uses of diverted water include municipal, domestic, agricultural, and industrial. SWRCB records list a total of over 1,500 water rights filings for the Russian River watershed. SCWA estimates that the present total diversion demand on the Russian River and its tributaries by all users, including agriculture and urban, is 110,000 to 120,000 AFY, depending on the amount of rainfall per year. Approximately 41,000 to 49,000 AFY of this demand occurs on the Russian River upstream from Dry Creek, where agricultural uses account for most of the total. Diversions along Dry Creek below Warm Springs Dam and along the Russian River downstream of the confluence with Dry Creek total approximately 70,000 AFY, including SCWA's diversions. Municipalities and agricultural interests are the primary diverters.

Approximately 12,900 AFY of mainstem water rights are senior to SCWA's and MCRRFD's water rights to direct diversion and storage in Lake Mendocino. These are not rights to water stored in Lake Mendocino, but only to water that is flowing into Lake

Mendocino. Therefore, to the extent that water flowing into Lake Mendocino would be available to satisfy these senior water rights, USACE and SCWA must allow water to pass through the Coyote Valley Dam to satisfy those senior rights.

3.3.2.3 Buildout Demand Level

More than 100 applications are pending before the SWRCB for permits to divert water from the Russian River and its tributaries. Most of these applications are for diversions on 13 different tributary systems. The total identified buildout demand is estimated by SCWA to be from 173,500 to 184,500 AFY at buildout demand level. (Buildout, as used in this BA, is defined as the demand conditions that SCWA's proposed WSTSP was designed to meet.) Approximately 58,000 to 68,000 AFY of the total buildout demand is projected to be upstream of the confluence with Dry Creek.

3.3.3 Transmission System Facilities

SCWA delivers water to its customers through its water transmission system, which currently has a reliable, summertime, average day per month delivery capacity of 84 mgd, and an allowed capacity of up to 92 mgd. The diversion and treatment facilities are located along the Russian River at Mirabel and Wohler. The distribution system includes pipelines, storage tanks, pumps, and groundwater wells, and conveys water from the diversion facilities on the Russian River to service areas in Sonoma County and in northern Marin County. The locations of SCWA's existing water transmission system facilities are shown in Figure 3-1. The operations and maintenance activities at the existing diversion facilities are described in the following sections.

3.3.3.1 Existing Diversion Facilities — Operation

SCWA's diversion facilities along the Russian River are located in the Wohler and Mirabel areas, on SCWA property (Figure 3-2). They include the inflatable dam, the Mirabel diversion facility and infiltration ponds, and the Wohler diversion facility and infiltration ponds. SCWA operates five Ranney collector wells and seven conventional wells adjacent to the Russian River near Wohler Road and Mirabel, which extract water from the aquifer beneath the streambed. Each Ranney collector well consists of a 13- to 16-foot-diameter caisson (i.e., concrete cylinder) that extends 80 to 100 feet deep into the streambed gravel. Perforated horizontal intake pipes extend radially from the bottom of each caisson to a maximum of 180 feet into the aquifer. Each collector well houses two vertical turbine pumps that are driven by 1,000 to 1,250 horsepower (hp) electrical motors.

Collector No. 6, a Ranney-type collector well and pumphouse currently under construction, is expected to commence operation in 2004. Collector No. 6 is located in the Wohler area, adjacent to the Russian River, north of Wohler Bridge and approximately 10 miles west of the City of Santa Rosa. The construction of this facility underwent informal consultation with NOAA Fisheries in 1999 (NMFS 2000b).

The ability of the Russian River aquifer to produce water is generally limited by the rate of recharge to the aquifer through the streambed near Mirabel and Wohler. To augment this rate of recharge, SCWA has constructed seven infiltration ponds (and one sedimentation pond). A water-filled inflatable dam is located on the Russian River just upstream of the Mirabel area (Figure 3-2). When the dam is inflated, it raises the water level and submerges the intakes to three diversion pumps. The water is pumped through pipes in the levee adjacent to the river into a lined ditch, which conveys water to five infiltration ponds encompassing a total area of approximately 40 acres. The backwater created by the inflatable dam also raises the upstream water level, allowing SCWA to flood two infiltration ponds (1.7 acres combined) in the Wohler area. The flow of water to these ponds is controlled by slide gates at the entrance of the canals serving each pond. The backwater created by the inflatable dam submerges a larger streambed area along the river, which increases water depth and submerged area. This significantly increases infiltration to the aquifer and increases the yield of all five Ranney collector wells.

Inflatable Dam

The inflatable dam is fabricated of a rubber material and is attached to a concrete foundation in the riverbed. When inflated, the dam is 11 feet high. The diversion facility is located on the west side of the river adjacent to the dam. The inflatable dam is usually raised in late spring when water demands increase and the Russian River flows drop below 800 cfs. The dam is lowered again in the fall or early winter when demands decline and river flows increase. Table 3-3 shows the dates that the inflatable dam was raised or lowered, and the corresponding river flows, between 1978 and 1998. During this period, the average river flow at the Hacienda gage was approximately 560 cfs when the dam was raised and lowered. Because of increasing water demands, SCWA has had to raise the dam at increasingly higher river flows. In general, the river flows are declining when the dam is raised and rising when the dam is lowered. The dam has been inflated for slightly under 7 months each year, on average. Under some spring conditions, when demands were rising sharply, the dam was raised when flows were between 1,000 cfs and 2,000 cfs. When the dam is deflated, it does not impede migration or create a backwater (Winzler and Kelly 1978).

When the dam is inflated and begins to impound water, flow over the dam is reduced, resulting in a decline of the river stage below the dam. The magnitude of the reduction in flow over the dam, and therefore the decline in stage, depends on the rate of inflation of the dam and flow in the river above the dam. Water spills over the dam until it is two-thirds inflated, at which point most of the flow passes through the ladders and associated bypass pipelines. Under current protocols, inflation of the dam generally takes approximately 12 hours to complete.

Deflation of the dam typically takes 24 hours to complete. Given that the dam is 11 feet high, stage-change in the river upstream of the dam can be estimated at approximately 0.46 ft/h during deflation.

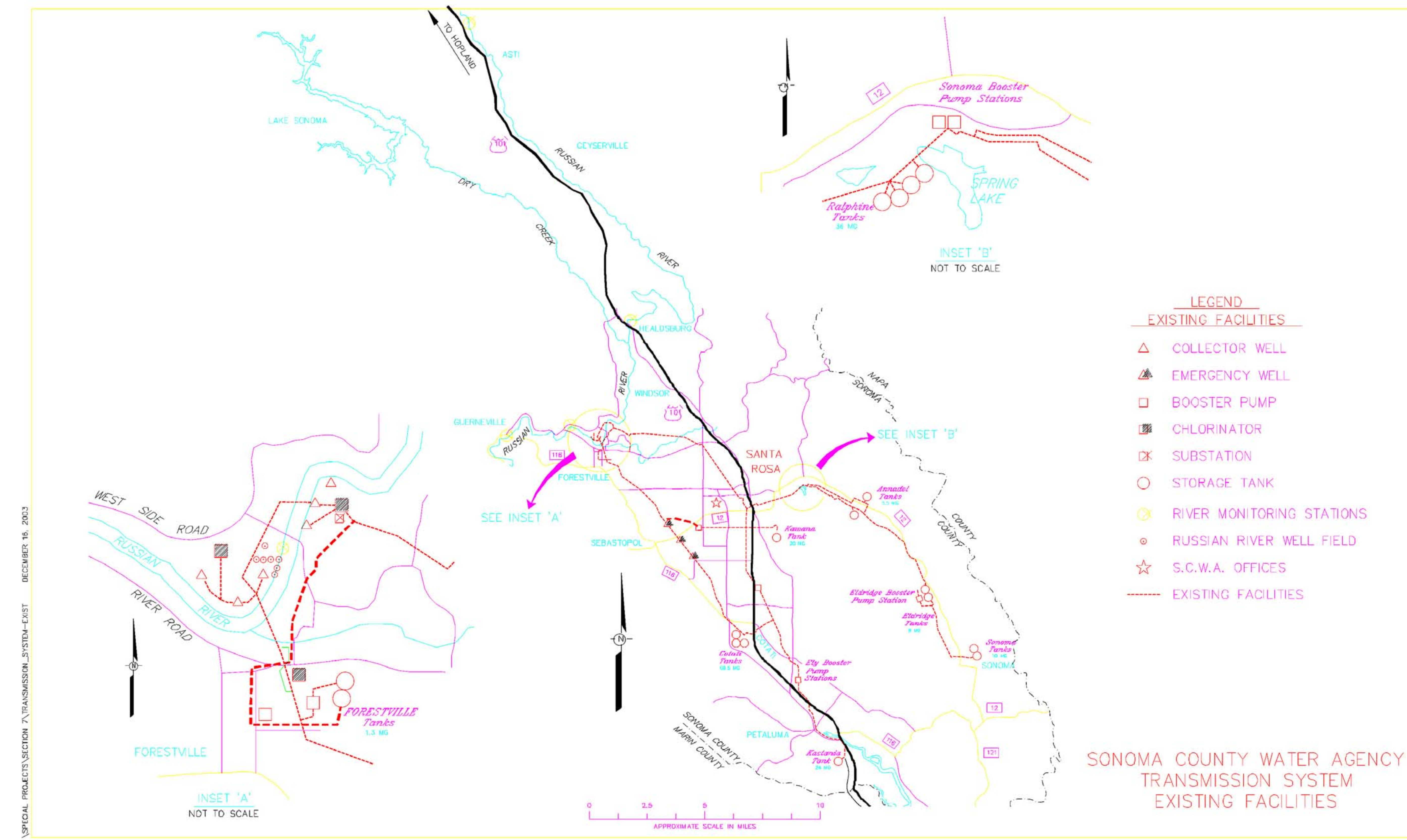

Figure 3-1 Sonoma County Water Agency Existing Transmission System Facilities

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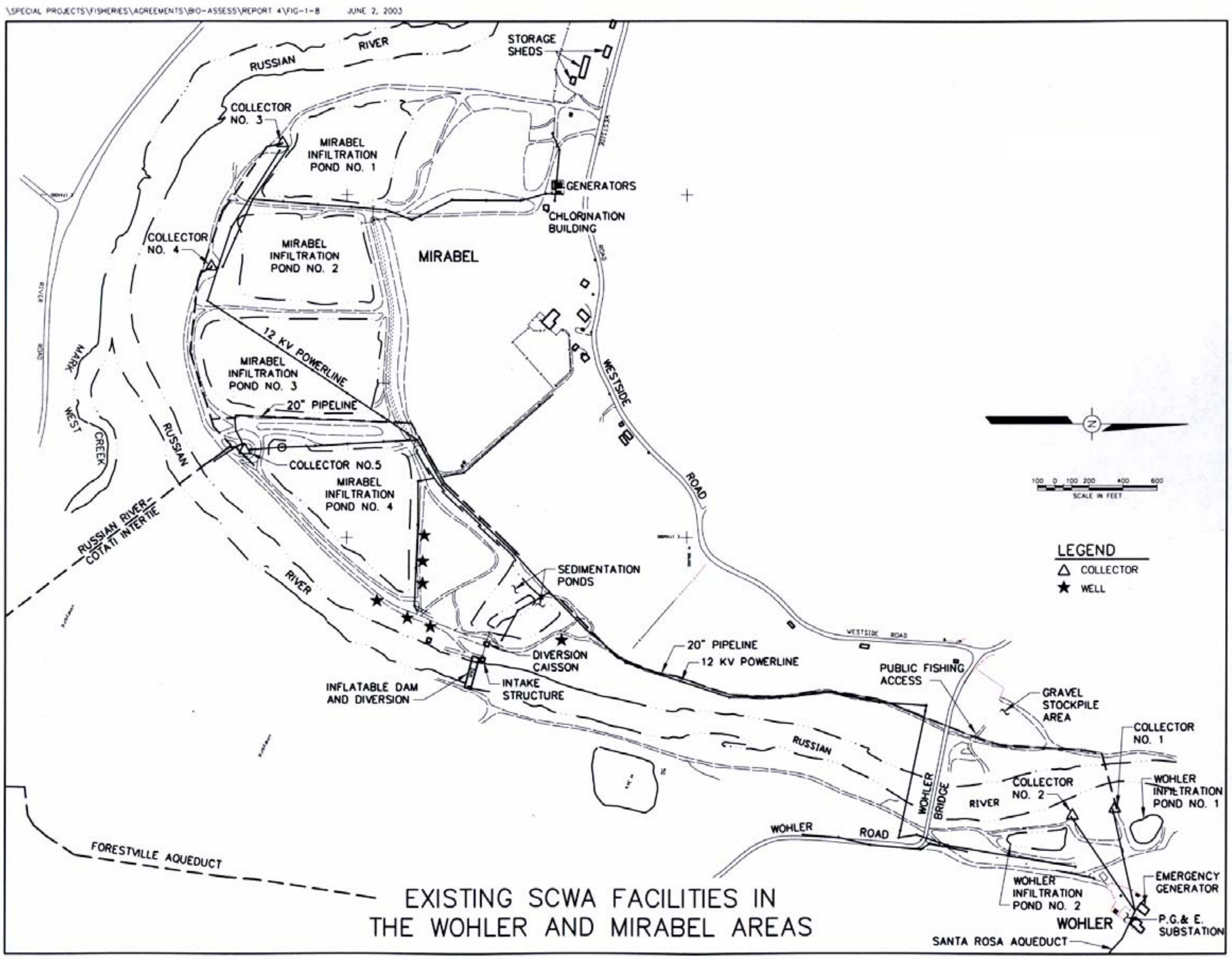


Figure 3-2 Sonoma County Water Agency Facilities in Wohler and Mirabel Areas

Table 3-3 Inflatable Dam Operation History

DATE		PRIOR 7 DAYS DEMAND LOW	HIGH	AVG	MAX TEMP LOW	HIGH	AVG	HACIENDA 8 AM FLOW (Raising)	HACIENDA 8 AM FLOW (Lowering)	7 DAY RAINFALL	SPECIAL NOTES
4/21/79	up	16.0	30.0	21.9	63	78	70			0	
10/7/79	down	26.1	31.2	28.6	75	87	80			0	
4/21/80	up	17.3	21.2	19.3	62	82	75			0.59	
9/14/80	down	32.7	37.2	34.9	71	81	77			0	
5/14/81	up	36.4	47.5	44.0	77	92	86			0	
10/7/81	down	25.4	36.3	28.9	67	87	76			0.77	
6/7/82	up	35.2	48.0	39.9	75	82	78			0	
10/7/82	down	29.4	34.2	32.2	68	80	76			0.05	
6/8/83	up	35.1	47.4	39.8	74	94	84			0	
10/19/83	down	25.8	30.4	28.1	72	78	76			0	
5/12/84	up	37.4	47.4	41.5	77	90	84			0	
10/17/84	down	29.6	35.1	32.2	57	74	69			0	
5/6/85	up	39.2	45.7	41.9	67	75	71			0	
10/21/85	down	27.4	45.9	37.5	61	82	69			1.13	
5/17/86	up	39.1	46.3	44.0	75	91	80			0	
10/21/86	down	35.9	42.8	39.3	64	77	70			0	
4/27/87	up	45.0	52.2	48.3	70	92	79	370		0	
11/12/87	down	30.1	36.2	33.5	64	68	67		248	0.38	
4/2/88	up	42.6	50.9	46.6	65	82	75	330		0	
11/2/88	down	34.2	42.3	39.0	58	75	66		174	0.15	
2/21/89	up	28.8	39.6	36.9	54	69	61	454		0.26	Hacienda flow 450 cfs North Marin Water taking 5-6 MGD extra with new pump
3/2/89	down	35.7	41.8	39.4	55	69	62		1536	2.03	Winter storm in progress HAC flow 1536 cfs
5/10/89	up	40.3	51.5	49.3	65	88	75	625		0	
10/1/89	down	34.9	47.3	42.6	70	75	72		241	0.64	Construction work for emergency diversion
10/10/89	up	40.0	51.9	46.2	74	86	79	229		0	Construction finished
10/23/89	down	35.9	49.9	42.4	53	76	65		560	2.71	STORM
12/12/89	up	31.7	39.3	35.8	55	65	59	331		0	Low rainfall YTD
1/7/90	down	30.0	38.1	33.7	51	58	55		331	1.72	STORM
4/4/90	up	37.9	45.6	41.3	63	77	67	354		0	Streamflows reduced for dry year
12/11/90	down	35.2	45.9	39.6	53	64	60		171	0.36	cool Wx. low demand
1/18/91	up	39.5	45.6	42.1	59	71	63	145		0.06	
2/2/91	down	41.2	45.1	44.1	55	66	60		278	2.23	STORM
2/13/91	up	39.2	41.8	40.5	61	73	66	246		0	
3/2/91	down	36.6	47.1	42	58	75	64		1547	3.64	STORM
5/10/91	up	38.8	49.6					465			Estimate - date inferred from records of pumping to ponds
12/23/91	down								203		Estimate - date inferred from records of pumping to ponds
1/23/92	up							351			Estimate - date inferred from records of pumping to ponds
2/9/92	down								420		Estimate - date inferred from records of pumping to ponds
4/30/92	up							553			Estimate - date inferred from records of pumping to ponds
12/2/92	down								221		Estimate - date inferred from records of pumping to ponds

Table 3-3 Inflatable Dam Operation History (Continued)

DATE		PRIOR 7 DAYS DEMAND LOW	HIGH	AVG	MAX TEMP LOW	HIGH	AVG	HACIENDA 8 AM FLOW (Raising)	HACIENDA 8 AM FLOW (Lowering)	7 DAY RAINFALL	SPECIAL NOTES
5/10/93	up							367			Estimate - date inferred from records of pumping to ponds
5/25/93	down								292		Estimate - date inferred from records of pumping to ponds
6/11/93	up							1120			Estimate - date inferred from records of pumping to ponds
11/9/93	down								356		Estimate - date inferred from records of pumping to ponds
3/14/94	up							708			Estimate - date inferred from records of pumping to ponds
11/9/94	down								409		Estimate - date inferred from records of pumping to ponds
12/26/94	up							837			Estimate - date inferred from records of pumping to ponds
1/3/95	down								1303		Estimate - date inferred from records of pumping to ponds
6/1/95	up							733			Estimate - date inferred from records of pumping to ponds
12/7/95	down								278		Estimate - date inferred from records of pumping to ponds
5/20/96	up							1660			
11/18/96	down								460		
3/26/97	up							477			Estimate - date inferred from records of pumping to ponds
11/16/97	down								1270		
5/23/98	up							910			
5/28/98	down								883		
6/12/98	up										
								753.8	1326.3		
								145	171		

The inflatable dam is equipped with Denil-style fish ladders near the riverbank on each side of the dam, both of which are in operation when the dam is raised. Each fish ladder has an approximate capacity of 40 cfs. Two 24- to 36-inch bypass pipelines provide water at each of the fish ladder entrances to attract adult fish to the ladder. Each bypass pipeline can allow approximately 22 cfs of flow. Downstream migrants can either pass over the dam, down the fish ladders, or through flow bypass pipes.

The bypass pipeline on the east side of the river causes excessive turbulence at the downstream entrance of the east-side fish ladder. The west-side bypass line and fish ladder function properly.

Diversion Structures and Infiltration Ponds

When the inflatable dam is raised, surface water is diverted into infiltration ponds at Mirabel and Wohler to increase water production.

<u>Mirabel</u>

At the inflatable dam, water is drawn through two rotating-drum fish screens to the diversion caisson, which houses three pumps capable of pumping a total of 100 cfs to the infiltration ponds. Diversion rates to the infiltration ponds are determined by demands on SCWA's water supply and transmission system. After flowing through a sedimentation pond adjacent to the diversion caisson, diverted water enters a small open channel, which distributes water to each infiltration pond through manually-operated slide gates.

Existing fish screens for the Mirabel pumped diversions were constructed in 1976 as part of the overall diversion facility, which included the inflatable dam foundation, inflatable dam fabric, diversion caisson, and other related equipment. The fish screens are submerged on the west side of the river in a side structure (pool), and when in operation, the screen function appears to have little variability in response to hydrologic conditions. The water surface elevation typically ranges from 37 feet to 38 feet MSL during normal summer operation.

The two fish screens at Mirabel are 11 feet in diameter, 5 feet 4 inches high, and rotate on a vertical axis. The top portion of the screens, which are submerged, have a different configuration than the rest of the screens; they are horizontal rather than vertical. Screen opening size is 5/32 inch. The diversion pumps are capable of pumping a total of 100 cfs through the screens. Vertical fixed brushes clean the screens of debris and biological fouling as the screens rotate.

Field measurements were taken to evaluate the performance of the screens in June 2000 (Borcalli & Associates 2000). Table 3-4 presents critical operating parameters for the Mirabel fish screens and compares them with NOAA Fisheries screen criteria. Most of the critical operating parameters and engineering design criteria meet NOAA Fisheries screening criteria for juvenile salmonids, but not salmonid fry. The rate of diversion during the test was 100 cfs, and the amount of water flowing through both bypass inlets simultaneously was estimated at 18.5 cfs. The approach velocities at the Mirabel screens averaged 0.18 foot per second (fps) at the downstream screen and 0.41 fps at the upstream screen. Field data indicate that large portions of the screens have approach velocities below 0.45 fps, and some areas have negative approach velocity values, indicating flows away from the screen (Borcalli & Associates 2000). There are small areas along the screens where approach velocities are higher, up to 0.95 fps. The screens rotate, while these "hot spots" remain in a stationary position. Average sweeping velocity was 1.04 fps at the upstream screen and 0.45 fps at the downstream screen. Some sweeping velocity is created as the screens turn. Test results indicate that most of the flow is pulled through the upstream screen.

Table 3-4 Critical Operating Parameters for Mirabel Fish Screens

Parameter	Mirabel Fish Screens	NOAA Fisheries Juvenile Criteria[2]	NOAA Fisheries Fry Criteria[2]
Net equivalent submerged screen area	345.6 square feet[1]		
Screen open area	40%	40% open area	27% open area
Approach velocity	Upstream: Average 0.41 fps Downstream: Average 0.18 fps	≤ 0.8 fps	≤ 0.33 fps
Sweeping velocity	Upstream: Average 1.04 fps Downstream: Average 0.45 fps	Greater than approach velocity (sufficient to sweep debris away from screen face)	Greater than approach velocity (sufficient to sweep debris away from screen face)
Screen opening size (square openings)	5/32 inches	≤ ¼ (8/32) inches	≤ 3/32 inches

[1] Calculated from original construction drawing.
[2] NMFS 1997

The drum screens were originally constructed with hydraulically-driven motors to rotate the drums past the vertical fixed brush, which keeps the screens free of silt and other debris. In 1995, after a leak occurred in one of the hydraulic lines, the hydraulic motors were removed and replaced with a water-jet drive system. A small water jet drives paddle blades attached to the top of the screen to rotate the screens. SCWA maintenance staff has also found that the river current itself is often adequate to rotate the screens without assistance from the water-jet drive.

<u>Wohler</u>

The Wohler diversion facilities consist of two ponds with a combined surface area of 1.7 acres. Currently, each pond is connected independently to the Russian River by a canal. These canals function as both inlets and outlets to the ponds. The Wohler ponds operate only when the inflatable dam is raised. Flows diverted into the Wohler ponds are not measured.

The conditions at the Wohler diversion, prior to 1999 modifications, are described in *Interim Report 4* (ENTRIX, Inc. 2001d). Prior to 1999, a screen constructed out of metal

T-posts and ¼-inch hardware cloth was installed in front of the inlet into the Wohler infiltration ponds.

Fish Rescue

The levees surrounding the infiltration ponds at Wohler and Mirabel are sometimes overtopped during floods, trapping fish in the ponds after the river level recedes. At Mirabel, this occurs only when the river rises to a gage level of approximately 37.7 feet, or 3 feet above its flood level (as measured at the Hacienda). Prior to overtopping of the Mirabel pond levees, the slide gates on the canals are opened to allow water to enter the ponds. Back-flooding of the Mirabel ponds reduces damage to the levees caused by overtopping. The canals, which are built through the levee of Mirabel pond No. 3, are typically opened when the river level reaches approximately 36 feet, as measured at the Hacienda.

Wohler pond No. 1 is overtopped when the river rises to a gage level of approximately 18.3 feet (as measured at the Hacienda), or 12,700 cfs. Wohler pond No. 2 is overtopped at 17.3 feet, or approximately 10,600 cfs. Both of the Wohler ponds have flooded for extended periods of time during most winters.

Before 1996, CDFG informally conducted post-flooding fish rescue efforts at Wohler and Mirabel facilities as needed. SCWA assumed responsibility for fish rescue efforts with the establishment of its Fisheries Enhancement Program (FEP) in 1996. Fish rescues are accomplished by wading the ponds with beach seine nets after pond levels drop to a depth where wading is possible.

3.3.3.2 Existing Distribution System – Operation

SCWA's distribution system includes pipelines (also referred to as aqueducts and interties), storage tanks, booster pump stations, and groundwater wells (Figure 3-1). Each of these facilities is operated to meet system demands. The pipeline system is designed to carry the anticipated average daily demand during the month of maximum demand (peak month), usually July or August. (Peak demand on the water transmission system reached a maximum average monthly demand of approximately 81 mgd in July 2003.)

The facilities are operated using standard BMPs and are covered by spill prevention containment and control plans and emergency operations plans that outline safe operating protocols. The emergency plans provide procedures to avoid and respond to accidental spills and releases of hazardous substances (SCWA 1998c). These plans avoid and minimize adverse impacts associated with emergencies and other unplanned events. The facilities covered by these plans include:

Reservoirs and Booster Pumping Stations

The Russian River Water System	Annadel Reservoirs 1 & 2
Cotati Reservoirs	Forestville Reservoirs
Forestville Booster Pump Station	Ralphine Reservoirs
Wilfred Ave Booster Pump Station	

Production Wells

Occidental Road Well	Sebastopol Road Well
Todd Road Well	

Mirabel – Wohler Area Pumping Plants and Chlorination Facilities

Wohler Pump Plant	pH Building – Wohler
Mirabel Chlorination Building	River Road Facilities
Cotati Intertie/Building	pH Building – River Road
Wohler Chlorination Building	Forestville Fire Department
Operations and Maintenance Service Center	

The pipeline system is designed to carry the anticipated average daily demand during the month of maximum demand (peak month), usually July or August. (Peak demand on the water transmission system reached a maximum average monthly demand of approximately 81 mgd in July 2003.)

The original pipeline system (consisting of the Santa Rosa Aqueduct, the Petaluma Aqueduct, and the Sonoma Aqueduct) was constructed in the late 1950s and the early 1960s. The two collector wells at Wohler provided the water supply to this original system. In the mid-1970s, demands in the service area increased, and the Russian River-Cotati Intertie pipeline and the three collector wells at Mirabel with connecting pipelines and additional storage tanks were authorized by the SCWA's water contractors. The Russian River-Cotati Intertie pipeline and two collectors were constructed immediately, and most of the remaining facilities were constructed in subsequent years.

Collector Wells

Ten vertical turbine pumps, two installed in each of the five Ranney collectors, provide the primary pumping for the distribution system. Each pump at Wohler is rated to deliver up to 10.0 to 11.5 mgd, and at Mirabel each pump is rated to deliver up to 10.0 to 14.5 mgd, although the highest pumping rates cannot be sustained on a continuous basis. The pumping capacity of each of the collectors is limited by aquifer constraints and heavily dependent on the current storage and pumping status of other water transmission components. For example, one Wohler pump operating by itself will produce approximately 11 mgd, three pumps operating at Wohler produce approximately 27 mgd, and four pumps produce a total of approximately 30 mgd.

Conventional Wells

Seven conventional wells, collectively referred to as the Russian River Well Field, are located in the Mirabel area, as shown on Figure 3-2. These wells withdraw water from the aquifer adjacent to the Russian River. The wells provide up to 7 to 9 mgd of additional production capacity. Water from the Russian River Well Field may either be sent directly to the Cotati Intertie, or it may be discharged into Caisson 1 and re-pumped into the Santa Rosa aqueduct.

The SCWA system includes three groundwater wells located along the Russian River-Cotati Intertie pipeline at Occidental Road, Sebastopol Road (Highway 12), and Todd Road. Prior to 1999, these wells were used for emergency purposes only and were pumped for approximately 20 minutes each month to maintain their operability.

Gaseous chlorine is added to the water produced at the Occidental Road well site to maintain protective residual levels of chlorine within the system and prevent contamination. At the Sebastopol Road and Todd Road wells, calcium hypochlorite ($CaCl_2O_2$) tablets are used on-site to generate an aqueous chlorine solution. In addition, a treatment system has been installed at the Todd Road well, which adds a small dose of an ortho-polyphosphate compound to the well water. The treatment was installed to determine whether it would be effective at eliminating the hydrogen sulfide odor, which frequently occurs in the water produced at all three wells. Although the hydrogen sulfide does not affect the potability of the water, it is a secondary water quality concern, which significantly affects its odor.

Storage Tanks and Booster Pump Stations

Storage tanks provide water storage for emergencies, to meet peak demand during maximum demand periods, and to provide hydraulic stability. Sixteen steel water storage tanks in the system provide a combined storage capacity of 118.8 million gallons. Their locations and capacities are given in Table 3-5.

Table 3-5 Location and Capacities of Water Storage Tanks

Tank Name	General Location	Number of Tanks	Total Capacity (million gallons)
Ralphine	Santa Rosa	4	36.0
Cotati	Cotati	3	36.0
Forestville	Forestville	2	1.3
Annadel #1	Santa Rosa	1	2.5
Annadel #2	Santa Rosa	1	3.0
Eldridge	Valley of the Moon	2	8.0
Sonoma	Sonoma	2	10.0
Kastania	Petaluma	1	12.0
Kawana #1	Santa Rosa	1	10.0
TOTAL		**17**	**118.8**

Operation of the water storage tanks in the SCWA system sometimes requires discharges of water from the tanks. These discharges are mostly under controlled conditions, although accidental, uncontrolled discharges may occur in some circumstances. This could result from a failure in valve control equipment, which is expected to be very infrequent.

The water transmission system also includes eight booster pump stations. Booster pumps are necessary to increase water pressure and/or to move water to areas of higher elevation. The station name, number of pumps at each station, and rated horsepower of each pump are shown in Table 3-6.

Table 3-6 Location and Rating of Booster Pump Stations

Station Name	Number of Pumps	Total Rated Horsepower
Forestville #1	2	15
Forestville #2	2	60
Sonoma #1	3	855
Sonoma #2	1	250
Wilfred	1	700
Ely	2	1,000
Eldridge	1	75
Kastania	2	650
Kawana	3	1,500

The Kawana Springs Pipeline and Kawana Booster Station were authorized prior to the WSTSP and are currently operational. The booster pump station is located in west Santa Rosa, near the intersection of Sebastopol and Wright roads.

Construction of Kawana Springs Tank No. 1 has been completed. The tank is located in an unincorporated area of Sonoma County south of the city of Santa Rosa, approximately 0.75 mile east of the intersection of Kawana Springs Road and Petaluma Hill Road. The tank location is shown in Figure 3-1. The steel tank has a capacity of 10 mg, increasing the total storage capacity of the existing transmission system to 118.8 mg.

Pipelines

The Kawana Springs Pipeline connects the Russian River-Cotati Intertie to Kawana Springs Tank No. 1. The Kawana Springs Pipeline consists of approximately 41,700 linear feet (lf) of 36-inch-diameter pipeline, and will serve to meet the demand, storage, and pressure requirements on the transmission system in the south Santa Rosa area.

The Wohler-Forestville Pipeline was also authorized prior to the WSTSP. Construction is expected to begin in early 2004. This pipeline will extend from SCWA's facilities at the Wohler area, generally parallel the existing Forestville Aqueduct for approximately 2.5 miles, and connect with the existing Russian River-Cotati Intertie pipeline near Forestville. The pipeline will consist of approximately 12,000 lf of 36- to 60-inch-diameter pipe. The pipeline will connect the 20 mgd of standby capacity provided by Collector No. 6 to the Russian River-Cotati Intertie pipeline.

The pipelines in the SCWA water transmission system include valves, which may occasionally discharge potable water to various creeks and drainage swales or ditches. These valves were installed to protect pipelines by relieving the pressure surges created when an abrupt change in flow occurs. Most, if not all, pressure surges and discharges occur when power outages trigger a sudden pump shutdown. Seventeen valves (6 slow-closing air valves and 11 surge valves) exist in the SCWA system. Potable water may also be discharged from tank overflow lines, although this occurs far less frequently. The maximum residual chlorine concentration in these discharges is approximately 0.6 parts per million (ppm). Discharges into Santa Rosa and Mark West creeks occurred in 2002 and 2003 respectively.

Cast magnesium alloy anodes are attached to the buried pipeline system at regular intervals for cathodic protection. The anodes generate a small electrical current in the pipeline that prevents corrosion on the exterior of the SCWA pipeline. These anodes are replaced after several years. The buried anodes are typically installed at every 20 to 40 feet. SCWA has an ongoing program to install anodes on approximately 2,000 to 4,000 feet of unprotected pipeline each year. Anode test stations consist of a wire lead to the ground surface, which allows the anodes to be tested without excavating the pipeline. Installation of anodes and anode test stations involves excavation with a backhoe tractor to expose the pipe joint material. Where pipelines cross creeks or other waterways, anodes are installed on either side of the crossing behind the tops of the banks. In areas where anodes cannot be installed over a significant distance, a small direct current is applied directly to the pipeline.

3.3.3.3 Existing Water Treatment Facilities – Operations

Water is diverted from the Russian River after it is filtered through the sand and gravel aquifer below the streambed and infiltration ponds, and thus requires no further filtration.

In September 1995, SCWA completed construction of pH adjustment/corrosion control facilities to limit lead and copper content in drinking water. This system was constructed in response to 1991 Environmental Protection Agency (EPA) regulations. These facilities are located at the SCWA Wohler maintenance yard and the River Road chlorination building. The facilities treat water in each of SCWA's two primary water transmission lines, the Russian River-Cotati Intertie pipeline and the Santa Rosa Aqueduct, with caustic soda. Although the water produced by the existing collectors contains no detectable levels of lead and copper, the water is naturally moderately corrosive and can leach lead and copper from indoor plumbing and water fixtures. Corrosion control treatment also assists the water contractors and other sanitation districts to meet water quality limits on the dissolved metals content in treated sewage discharges, which are even more stringent than the limits for drinking water.

SCWA currently adds approximately 0.6 ppm chlorine for disinfection at three chlorination facilities. Calcium hypochlorite is currently used at the Sebastopol Road and Todd Road well sites, eliminating the need for chlorine gas cylinders at these sites. Chlorine is stored in 100-lb. cylinders at the Occidental Road well site. Chlorine is normally delivered to SCWA's chlorine buildings in 1-ton pressurized cylinders. The pressurized cylinders are constructed in accordance with strict regulations and are capable of withstanding severe shock if dropped. The chlorine is mixed with water inside the chlorine buildings to form a concentrated chlorine and water solution. This chlorine and water solution is transported through underground pipes to each collector. The chlorine and water solution is injected into the collector caissons to sanitize the water. The chlorine storage buildings are equipped with leak detection alarm systems that send a signal to the operations and maintenance center indicating any leak locations; the alarm also sounds at the chlorination building. Installation of chemical scrubbing systems to control leaks were completed by the end of 2003 at each of these chorine storage buildings.

The caustic soda for water treatment is purchased as a 50:50 water/sodium hydroxide solution, delivered by tanker trucks, and stored in two 10,000-gallon containers (one at Wohler and one at the River Road facilities). The Wohler pH control building is located approximately 250 yards from the Russian River. The River Road pH control building is located approximately 200 yards from Mark West Creek. The concrete masonry walls of the pH control buildings are designed to provide secondary containment to prevent the caustic soda from contaminating a large area if a leak occurs within the pH control buildings. The caustic soda is used by SCWA to raise the pH level of the water, thereby reducing the corrosion of copper pipes in household plumbing, which will help wastewater treatment facilities meet the discharge standards for copper. In its concentrated form (50 percent solution), the caustic soda has a corrosive action on body tissues. It can cause burns, deep ulcerations, and scarring. The caustic soda does not have the low boiling point of chlorine, and is safer to handle or contain in the event of an accidental spill. The primary hazard of concentrated caustic soda is its extreme corrosivity.

Minor amounts of chlorinated water are discharged from the Ranney collector wells and other nearby facilities. These may be discharges from sampling and motor cooling lines in the collector wells, which operate continuously; from pumps used to dewater the Ranney collector wells for maintenance; from the inflatable dam as it is lowered; or from other related activities. Water from motor cooling lines is discharged at an estimated rate of approximately 5 gallons per minute (gpm) when the pump motors are running. This discharged water at the Mirabel facilities flows into the settling and infiltration ponds. At Wohler, this discharge water flows into the Russian River. SCWA is currently looking into other options for cooling to alleviate this discharge. These incidental discharges and the pipeline discharges are covered under a waiver issued by the NCRWQCB in 1987 (RWQCB Resolution 87-113).

Early Warning System

The Early Warning Station Project, designed to detect the presence of contaminants in the Russian River, was initiated in 1991 in response to requirements set forth by the CDHS as part of SCWA's domestic water supply permit. Three early warning station sites were constructed in Sonoma County. Early Warning Station No. 1 is located near the Mirabel diversion facilities. Early Warning Station No. 2 is located near Mark West Creek, just downstream of its confluence with Windsor Creek. Early Warning Station No. 3 is located near the Healdsburg Memorial Dam on the westerly bank of the Russian River.

Each early warning station consists of a river intake, river sample and discharge line, biomonitor and physiochemical monitors, and auto sampler and telemetered alarm system housed within an 8-foot by 12-foot masonry or metal building. The original early warning system was designed to use the behavior of living organisms (fish or aquatic invertebrates) to detect contaminants. All three of the early warning stations are not operational due to problems with clogging filters. Because of the ongoing operation problems, the use of living organisms to detect contaminants is no longer being considered at the present time.

In October 1998, SCWA tested a water quality monitoring probe at the Mirabel diversion structure for approximately one month. The water quality probe performed well and demonstrated the performance desired by SCWA. SCWA will use these probes to monitor for DO, pH, temperature, turbidity, depth, and conductivity. The probe will not directly detect toxic materials; however, a spill in the river would be expected to alter at least one of the parameters being monitored. If an anomaly is detected, samples will be collected and sent to a laboratory for analysis. Due to the changing parameters of the project, SCWA is referring to the project as the "River Monitoring Stations Project" rather than the "Early Warning Station Project."

The River Monitoring Stations Project includes five river monitoring stations. SCWA has constructed five stations at four USGS gaging stations (located at Hopland, Healdsburg, Hacienda, and Guerneville), and one at the Mirabel diversion structure.

3.3.3.4 Existing Diversion Facilities – Maintenance

Road and Levee Maintenance

Main levee roads on the west side of the river in the Mirabel area are gravel roads that are maintained on an as-needed basis after storms. The main levee road is between 100 and approximately 250 feet from the Russian River. Maintenance generally includes grading and replacement of gravel and vegetation maintenance (mowing, trimming, and vegetation removal). This road provides access to the Mirabel collector wells, infiltration basins, diversion caisson, and the west side of the inflatable dam. This road continues north underneath the Wohler Bridge along an intertie pipeline route that connects the Wohler and Mirabel facilities. This road is also used as an access location for periodic scraping of two large gravel bars that form under and upstream of the Wohler Bridge.

Access roads at Wohler are dirt roads that are generally maintained during the spring to repair damage from high river flows that can occur during the winter months. The road is used to access the Wohler collectors, and continues south along the east side of the Russian River to access the east side of the inflatable dam. Maintenance generally consists of repairing washouts and filling potholes. This road is approximately 200 feet from the Russian River.

Inflatable Dam Maintenance

Each time the dam is lowered, the fish screens at Wohler are removed so they are not damaged during high-water events. Raising the dam sometimes requires removing gravel that has accumulated during the winter on top of the flattened dam fabric and within the fish ladders. The accumulated sediment is removed using a portable suction dredge, and discharge is directed to a temporary siltation (settling) pond to prevent turbid water from reaching the river channel. The water is allowed to re-enter the river after the sediment has settled. Spoils are then stored out of the flood plain or hauled away.

Infiltration Pond Maintenance

Because silt and other organic materials accumulate on the infiltration pond beds and gradually impede infiltration to the aquifer after sustained use during the summer, the ponds are periodically drained and the silt and organic matter removed with a grader and scraper to restore infiltration capacity. The materials are stockpiled and removed over time by private contractors.

Extensive repairs are sometimes necessary for pond and levee maintenance at the Mirabel and Wohler sites if they are overtopped during flood conditions. When the river overtops the Mirabel levee at its low points, cascading water on the inboard side of the levee causes substantial erosion damage to the levee embankment. Culverts that run through the levees at Mirabel are equipped with slide gates so they can be opened during flood conditions. If overtopping of the levees is probable, the slide gates are opened to fill the infiltration ponds and reduce erosion from water running over the top of the levees. Repairs to the levee require replacing the eroded material and rock riprap on the embankment. Flood water also deposits as much as 1 to 2 feet of impermeable silt material in the pond beds, which must be removed before the ponds can be used again. The removed material is placed on separate stockpiles at the Wohler and Mirabel sites.

Gravel Bar Maintenance

In addition to the infiltration ponds, SCWA augments infiltration rates by periodically scraping gravel bars in the river diversion areas to increase infiltration in the river. The gravel bars are graded to lower the level of the streambed so that the area is flooded when the inflatable dam is raised. A detailed discussion of gravel bar grading operations and channel maintenance activities is provided in Section 3.6.

3.3.3.5 Existing Distribution System – Maintenance

Groundwater Wells Maintenance

Operation of SCWA's Occidental Road, Sebastopol Road, and Todd Road wells frequently requires discharging well water to surface drainages for sampling or flushing purposes. These discharges usually involve unchlorinated water, although minor discharges of chlorinated water from nearby locations on the Russian River-Cotati Aqueduct pipeline may be necessary for sampling purposes. This sampling is for water quality parameters that are normally used to determine compliance with potable water regulations.

Water Storage Tanks Maintenance

Maintenance of the water storage tanks includes periodic recoating of the interior tank surfaces, which requires that the tanks be emptied. To the extent possible, the water in the tanks is drained into the transmission system. However, to maintain pressures within the transmission system, a portion must be released from the tank to surface water drainage. In these cases, the SCWA maintenance staff estimates the remaining volume and adds a corresponding amount of dechlorinating chemical (metabisulfide) to eliminate any chlorine residual in the discharge.

Controlled discharges occur approximately once every 4 years as part of maintenance activities. Controlled discharges are done only after obtaining permission from the CDHS and the NCRWQCB. The Forestville tanks are the SCWA's closest tanks to the Russian River (approximately 1 to 2 miles). Discharges from the Forestville tanks flow into a riprapped drainage ditch adjacent to the access road off Anderson Road in Forestville. Riprapping in the drainage ditches serves to dissipate the energy of discharged flows to reduce the potential for erosion. Discharges into this ditch flow in a southwesterly direction towards an unnamed tributary of Atascadero Creek approximately 0.5 miles to the south. Atascadero Creek is a tributary of Green Valley Creek, which eventually flows into the Russian River.

Overflow pipelines in each water storage tank provide a necessary emergency release route if water levels in the tank should unexpectedly rise too high. While automated control valves in the water transmission system have been installed to prevent this, overflows may nonetheless occur under certain unforeseen circumstances. In these cases, chlorinated water may be discharged to surface water drainage. At a maximum, the water in the tanks would have a chlorine level of approximately 0.6 ppm.

Equipment Maintenance

Maintenance of equipment is a continual process with varying work schedules. Maintenance of facilities occurs on a weekly, monthly, quarterly, annual, and tri-annual basis. In some cases, maintenance work on diversion and distribution facilities is performed inside the facility (inside the caisson or motor housing); in other cases, the equipment is brought back to SCWA's operations and maintenance building in Santa Rosa for maintenance. The storage yard at Mirabel is used to store small amounts of supplies needed for maintenance activities (e.g., paints, oils). Occasionally, the storage area at Mirabel is used as a staging area to store anti-freeze as part of maintenance activities associated with the diesel generators at Mirabel.

SCWA uses diesel fuel-powered generators for emergency and standby power production. SCWA has a total of approximately 31,000 gallons of diesel fuel storage capacity at various facilities. Diesel storage is located adjacent to the standby generators at the Wohler and Mirabel chlorine buildings. Both diesel storage locations are approximately 250 to 300 yards from the Russian River. Diesel fuel is stored in above-ground, double-containment tanks that are out of the floodplain. Concrete block walls around fuel tanks provide additional containment capability. Fuel tanks are designed, manufactured, and constructed in accordance with the Uniform Fire Code, the Uniform Building Code, and applicable local codes and ordinances.

3.3.4 Factors Affecting Species Environment Due to Water Supply Operations

3.3.4.1 Juvenile Salmonid Emigration Delay

When inflated, the Mirabel Dam and the impoundment (approximately 3.2 miles long) have the potential to delay outmigrating smolts. Because smolts have a finite time to complete the physiological change that prepares them to survive in salt water (smoltification), a substantial delay potentially reduces survival. To evaluate the effects of baseline activities, SCWA instituted a 5-year monitoring program to assess juvenile steelhead passage.

Chinook salmon smolt emigration does not appear to be delayed by the dam (Chase et al. 2003). As part of a mark-recapture study to estimate Chinook salmon smolt abundance, smolts captured in rotary screw traps were marked on a weekly basis and transported approximately 0.8 km upstream of the dam. Marks were alternated weekly. Few Chinook salmon smolts recaptured on the day following a change in mark bore the previous week's mark, which indicates the marked fish generally required less than 48 hours to pass the dam.

Data suggest that steelhead smolt outmigration is delayed when the dam is inflated (Manning 2003). From 2000 to 2002, SCWA used radiotelemetry to evaluate steelhead migratory behavior, passage, and survival in the seasonal impoundment (Wohler Pool) created by Mirabel Dam (Manning 2003). In spring 2000, 79 yearling steelhead smolts from the DCFH were surgically implanted with uniquely coded transmitters and released in groups of 19 to 20 fish on four occasions before and after the dam was inflated. Two telemetry receivers were used to track smolts in the impoundment and automatically record passage around the dam.

During 2001 and 2002, steelhead smolt movements were recorded with four fixed radio-tracking stations, each consisting of a three- or four-element Yagi antenna and datalogging receiver. The stations were located in a riverine control reach upstream of the impounded reach, within the impoundment, and downstream of the impoundment. The fixed stations were located as follows: Station 1, at the upstream end of the 4.5 km river reach; Station 2, at the upstream end of the 5.1 km-long impoundment; Station 3, in the dam forebay; and Station 4, 50 meters below the dam. To evaluate passage routes at the dam, Station 3 was configured to simultaneously monitor an array of one aerial and six underwater antennas.

Results of the 2001 study suggested that smolt passage was slowed by shallow depth over the dam spillway and low velocities in the forebay. In spring 2002, the level of dam inflation was varied to increase depth and velocity (notch configuration).

2000 Results and Significant Findings

Radiotelemetry data from 79 radio-tagged steelhead smolts showed that the percentage of fish passing the dam site decreased over time and differed substantially before (85 to 90 percent passing) and after (42 to 50 percent passing) the river was impounded (Manning et al. 2001). With the dam inflated, between 50 and 95 percent of the smolts released spent more than 48 hours in the impoundment. Some of the steelhead smolts that eventually passed the dam resided in the reach for up to 11 days before passing. Smolt reluctance to pass the dam appeared to be related to depth and flow conditions in the forebay near the dam. The delay of some steelhead may have been exacerbated by the onset of parr-reversion (i.e., reverting back to a pre-smolt condition), stress related to surgery, and elevated water temperatures.

2001 to 2002 Significant Findings (Chase et al. 2003, Manning et al. 2003)

1. Year 2001 and 2002 data showed that steelhead smolts traveled through the riverine control reach and impoundment at roughly the same rate, despite the decreased velocity in the impoundment. The similarity in travel rates between impoundment and river suggests that delays associated with the impoundment are limited to the forebay near the dam. Differences in magnitude of flows over the study period did not appear to affect travel rate, and smolts from different hatchery-year classes performed similarly.

2. Residence time in the river above the dam did not differ significantly among years.

3. Forebay residence time was much lower in 2002 than in 2001. While small sample size may not have yielded enough statistical power to detect differences between the notched and full dam configurations in 2002, the notch may have been effective at reducing forebay residence time.

4. The ability to compare passage among years was partially confounded by the release of half the smolts at the upstream end of the impoundment in 2002. Although fish that showed little inclination to move from the upper impoundment release site were disregarded, a higher-than-expected proportion of fish from those releases failed to reach the forebay. During 2002, 47 percent of the fish entering the impoundment were never detected in the forebay–a three-fold increase over 2001. Conversely, by not accounting for some fish that would have remained in the river reach had they been released above Station 1 (the most upstream station), the proportion of fish entering the impoundment that passed the dam in 2002 was underestimated.

Environmental conditions unrelated to dam operation, such as elevated water temperatures and decreased flow, can potentially affect downstream migration. In 2000, mean daily water temperature increased from 16°C on April 20 to 23°C on June 29. Mean daily flow (measured at the USGS Hacienda gaging station) generally declined over the course of the study period. (Although storm events occasionally produced high peaks, all study fish passed the dam site before flows increased.) The percentage of radio-tagged steelhead that successfully passed over the dam decreased over time. However, the percentage of smolts that were detected but failed to pass differed substantially before and after the dam was inflated. This indicates that the dam affected passage.

Dye-marked steelhead smolts (released in conjunction with radio-tagged steelhead) in the forebay of Mirabel Dam on May 23, 2000 were observed to swim against the current near the dam and avoid being swept over the dam. The combined effects of low attraction velocities at the bypasses and ladders, shallow water at the crest of the dam, and rapid acceleration of flow over the crest of the dam may discourage smolts from passing the dam (Manning 2001).

Chinook salmon passage may be more successful because Chinook salmon smolts are smaller than steelhead smolts (Chase et al. 2002) and may be more likely to pass over the dam or through the bypasses and ladders.

3.3.4.2 Entrainment and Impingement at Fish Screens

Mirabel Diversion Fish Screens

Engineering design and critical operating parameters for the two fish screens at the Mirabel diversion mostly meet NOAA Fisheries criteria for juvenile salmonids. Although some small areas on the screens have approach-velocities higher than NOAA Fisheries criteria, particularly on the upstream screen, the risk of impingement on the screens for juvenile salmonids is low.

Because the Mirabel screen design is not within NOAA Fisheries criteria for salmonid fry (juvenile fish less than 60 mm long), there is a higher risk of impingement or injury to salmonid fry. SCWA screw trap data from 2002 have documented hundreds of Chinook salmon juveniles smaller than 60 mm FL during the Chinook salmon downstream migration period (Chase et al. 2002), although thousands of Chinook salmon were documented. Weekly average Chinook salmon lengths were greater than 60 mm FL beginning in April, but Chinook salmon smaller than 60 mm were documented through the week of June 17. Average weekly YOY steelhead lengths were greater than 60 mm FL after the week of May 14. These data indicate that steelhead and Chinook salmon fry present in the early spring are at risk. However, the diversion is less likely to be in operation in early than late spring. Coho salmon fry are more likely to utilize tributary habitat and are therefore at a very low risk.

Wohler Diversion Fish Screens

Wohler diversion screen design and operation are not within NOAA Fisheries criteria for juvenile or fry. Young fish exposed to the facility have a high risk of entrapment, impingement, injury, or migration delay. In some years, the diversion may be operated earlier or later than the normal May-November period. However, the diversion is normally operated during a small portion of the coho salmon and Chinook salmon outmigration period and a larger portion of the steelhead outmigration period (approximately 40 percent overlap). Only 5 percent of the total river flow is diverted at Wohler. Combining these two components, juvenile coho salmon and Chinook salmon downstream migrants are at a low-to-moderate risk for entrapment, impingement, injury, or migration delay, primarily because the Wohler diversion operation does not overlap substantially with the juvenile outmigration period. The risk for steelhead entrapment, impingement, or injury is higher because the diversion operates during a greater portion of the juvenile outmigration period; therefore, steelhead juveniles are at moderate risk.

As discussed with the Mirabel diversion fish screens, Chinook salmon and steelhead fry present in the early spring are at risk of entrapment, but coho salmon fry are at a very low risk.

3.3.4.3 Overtopping at Mirabel and Wohler Ponds

Flood flows periodically overtop the river bank and flood the Mirabel and Wohler infiltration ponds. When floodwaters recede, fish may be entrained in the ponds.

Mirabel

Potential effects to listed fish species were evaluated in *Interim Report 4* (ENTRIX, Inc. 2001d). Of 35 water years modeled, Mirabel ponds would have overtopped 28 days or approximately 0.1 percent of the time. The ponds would have overtopped in December through March. Because the ponds at Mirabel do not overtop often, the opportunity for entrainment at Mirabel during high flows is small.

Because less than 5 percent of streamflow during flood events enters the Mirabel ponds, and the ponds overtop during only a very small portion of the steelhead juvenile migration period, steelhead are subject to low risk. Coho salmon and Chinook salmon juveniles are more likely to migrate through the area when the ponds overtop. They would be subjected to a moderate risk of entrapment or migration delays. However, the ponds do not overtop very often; thus, individual fish may be affected but the overall risk to the populations is low. Chinook salmon were found in the Mirabel ponds during rescue operations in 1998. Although some fish may be lost to injury or stress during rescue operations, rescue operations at the Mirabel infiltration ponds minimize the overall risk to the three listed fish species.

Wohler

The Wohler ponds were at a greater risk of being overtopped and flooded by the river than the Mirabel ponds. Computer simulations estimate that Wohler pond No.1 would have overtopped 533 days over 35 years, or 4 percent of the time, and Wohler pond No. 2 approximately 625 times (5 percent of the time). The Wohler ponds flood almost every year. In general, flooding occurs during November through April. The Wohler ponds are relatively small (1.7 acres combined), so only a small portion of the mainstem flood flow enters the ponds. Because Wohler Ponds overtop more frequently, the risk to listed fish species is higher than at the Mirabel ponds. SCWA has conducted fish rescues in the Wohler ponds when needed since 1996.

3.3.4.4 Stranding or Displacement from Flow Fluctuation from Inflation and Deflation of the Inflatable Dam

When the inflatable dam is raised or lowered, water levels downstream and upstream, respectively, of the dam can drop, creating an opportunity for stranding juvenile fish downstream or upstream of the dam.

Deflation

When the inflatable dam is lowered, flow recessions and dewatering of habitat occurs in 2 miles of river upstream, which could result in stranding of salmonids. *Interim Report 4* evaluated this risk (ENTRIX, Inc. 2001d). Generally, habitat in the reach that is affected by impounded water does not have characteristics conducive to stranding. The dam is not lowered frequently (on average less than two times per year), the channel shape presents little risk of stranding, and dewatering of the riverbed is unlikely. Therefore, deflation of the inflatable dam presents a low risk of stranding to juvenile salmonids if it is performed slowly enough. SCWA staff have noted stranding of warmwater fish species in one instance when the dam was deflated too quickly, but no stranding of salmonids has been observed.

Inflation

Inflation of the dam usually occurs when river flows have declined from winter levels. Although water may continue to spill over the dam during inflation, flow recessions occur downstream of the inflatable dam. Because river flows are often lower during dam inflation than deflation, and downstream habitat is more complex; the risk of stranding fish is higher.

The risk of stranding juvenile fish when downstream water levels recede depends, in part, on habitat features in the river channel. At low flows, habitat downstream of the dam includes shallow water habitats (riffles) that increase the risk of fish stranding during flow recessions. Flow from Mark West Creek and Laguna de Santa Rosa attenuate flow recessions caused by dam inflation in downstream reaches of the river. As flows from these watersheds decrease in the spring and summer, the level of this attenuation decreases.

Stage-changes at the USGS gage at Hacienda were evaluated for a series of ten inflation events covering a range of initial river flows. Typically, maximum stage-change at Hacienda occurs within the first few hours, before flow through the bypass pipelines is initiated. Maximum stage-changes ranged from 0.06 to 0.38 foot per hour. Stage data from the USGS gage at Hacienda during dam inflation under current protocols showed a stage recession of 0.08 foot per hour on April 22, 2001 (a *dry* year) and a maximum stage recession of 0.38 foot per hour on April 16, 2002.

However, the Hacienda gage is not directly downstream of the dam, and flow from the Mark West Creek and Laguna de Santa Rosa watersheds may have influenced stage-changes at the gage. Stage-changes closer to the inflatable dam are larger.

3.3.4.5 Temperature

When the inflatable dam impounds water, water temperatures may increase. Similar effects may occur related to deepening areas of gravel bars downstream of the dam. An ongoing SCWA 5-year monitoring study (initiated in 2000) is producing data to assess potential effects. The inflatable dam operation is basically a run-of-the-river operation, and data suggest only a slight increase in water temperature through the Wohler Pool (approximately 0.5°C in August) (Chase et al. 2002). Steelhead rearing may occur in the area, but coho salmon are thought to use the area solely for passage. Chinook salmon juveniles migrate out by the end of June. By summer, temperatures in the inflatable dam impounded area, as well as free-flowing areas above and below the dam, are warmer than published water temperature criteria for salmonids. This small increase in temperature (0.5°C) in August is not likely to affect smolts, which migrate through the area earlier in the year, but may slightly reduce the quality of rearing habitat during the summer.

3.4 FLOW MANAGEMENT

3.4.1 FLOW REQUIREMENTS UNDER D1610

Lake Sonoma and Lake Mendocino are currently operated in accordance with criteria established by D1610 (SWRCB 1986b). D1610 adopted, with one minor change, the criteria included in an agreement between CDFG and SCWA that established minimum flow requirements for Dry Creek and the Russian River (SCWA and CDFG 1985). Minimum streamflows under D1610 are specified for four different reaches in the Russian River watershed: the East Fork Russian River from Coyote Valley Dam to the confluence with the mainstem, the mainstem Russian River between the East Fork Confluence and Dry Creek, the mainstem Russian River between Dry Creek and the mouth, and Dry Creek downstream of Warm Springs Dam to the confluence with the Russian River. D1610 represents the baseline minimum instream flow conditions evaluated in the BA.

Under D1610, required minimum flows in both the upper and lower Russian River vary depending upon water supply condition. Water supply condition is determined based on the cumulative inflow to Lake Pillsbury on the first of each month between January and June and is represented as *critically dry*, *dry*, or *normal*. The water supply condition can vary from month to month until June 1 when it becomes set until the following January.

Within the *normal* water supply condition, there is a separate schedule referred to as the *dry spring* criteria that is dependent upon the total combined storage in Lake Mendocino and Lake Pillsbury on May 31 of each year. The *dry spring* criteria affect releases from Lake Mendocino. These criteria allow reductions in minimum flows for the mainstem Russian River when the combined storage falls below 90 percent and 80 percent of the combined capacities of Lake Pillsbury and Lake Mendocino. This provision reflects the "flashy" hydrology of the basin and the fact that the water supply is dependent on not only the quantity of runoff, but also the timing of runoff. Flood control operations do not allow conservation of winter runoff so fully filling the water supply pool requires spring runoff. Historically, in approximately 11 percent of years, *dry spring* water supply conditions prevail from June through December. *Dry spring* conditions do not apply to the January through May period.

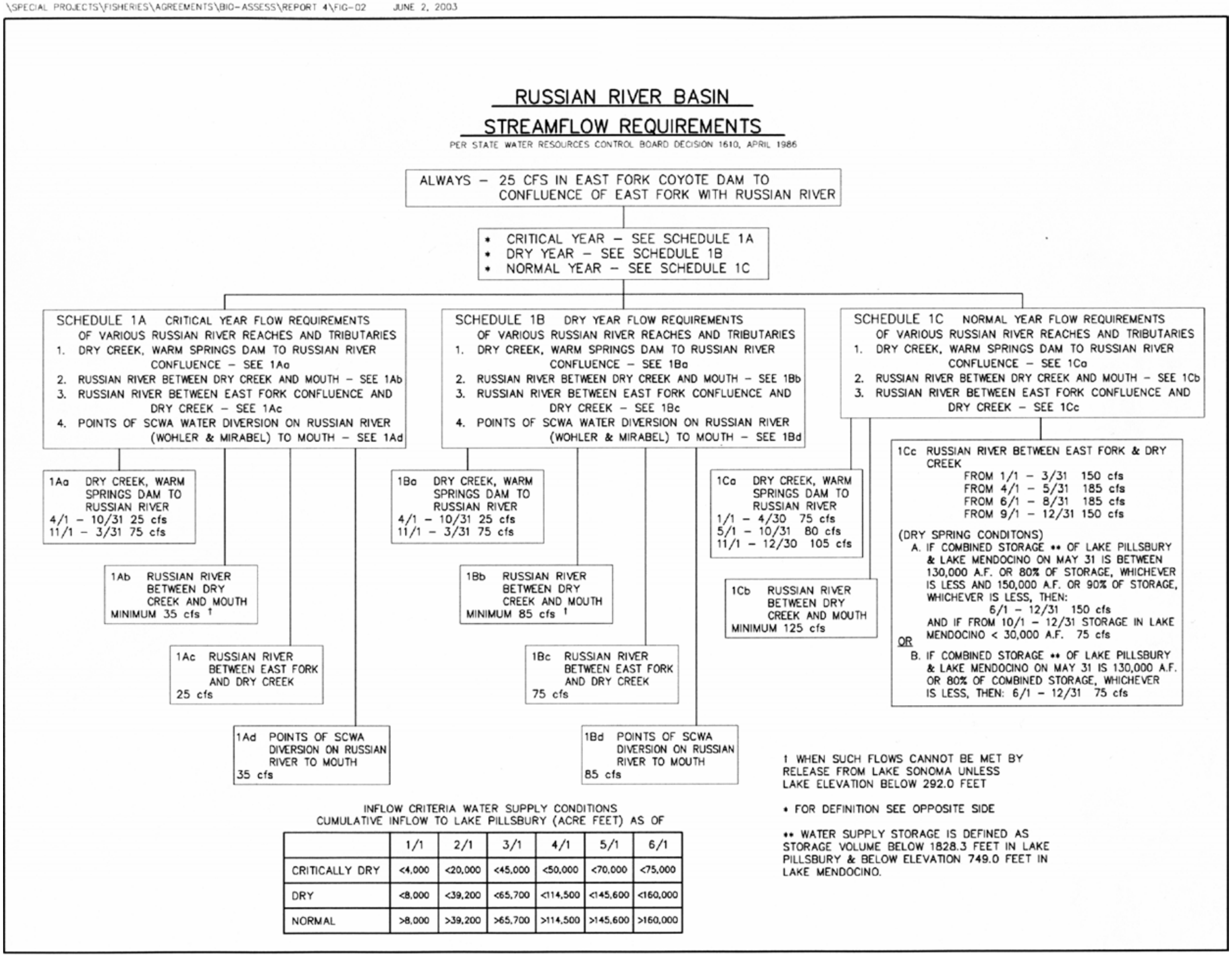
Figure 3-3 summarizes the minimum flow requirements contained in D1610. In the Russian River system, minimum flow rates are required to be maintained throughout entire reaches of the river, rather than at specified points. In the Russian River between Lake Mendocino and Healdsburg, separate minimum flow requirements apply to the short reach between Lake Mendocino and the mainstem Russian River, and to the mainstem between the confluence of the East Fork and Dry Creek. The point on the river with the lowest flow, referred to as the controlling point, determines the reservoir release. The location of the controlling point changes during the year. In the winter, when flows are increasing downstream, the controlling point is just below Coyote Valley Dam. In the summer, when tributary inflows have receded and flows are reduced by diversions, the controlling point is the Healdsburg gage. The transition from upstream to downstream control usually occurs during a period of 1 to 3 weeks in May or June, depending on the amount of spring rainfall. D1610 sets separate minimum instream flow requirements for the lower Russian River below Healdsburg and for Dry Creek.

The flow requirements under D1610 for the Russian River from Lake Mendocino to the Dry Creek confluence were based in part upon an evaluation of fish habitat and migration barriers (Winzler and Kelly 1978). These flow requirements were intended to maintain the highest sustainable flows possible to support the steelhead and salmon fishery below Coyote Valley Dam and instream recreation, and to avoid dewatering Lake Mendocino (SWRCB 1986b). The flow requirements were set with the assumption that the water supply available from Lake Mendocino would be sufficient to satisfy flow needs between Lake Mendocino and Dry Creek, and expected authorized diversions along this reach of the Russian River.

The instream flow requirements for the Russian River downstream from its confluence with Dry Creek during *normal* water supply conditions were based primarily on a desire to maintain flows upon which the recreational canoeing industry on the Russian River had previously developed. The reduced minimum instream flow requirements for *dry* and *critically dry* water supply conditions were determined in consideration of warmwater fish and wildlife needs, particularly for the lower portion of the Russian River.

The flow requirements for Dry Creek were based on the CDFG instream flow needs investigation performed in 1975 and 1976 (Barraco 1977). These requirements were developed to meet the fish spawning, passage, and rearing needs as determined by CDFG at that time. These flows were to sustain the native fish populations below Warm Springs Dam, to enhance steelhead and salmon spawning and nursery habitat in Dry Creek, and to facilitate operations of the DCFH at Warm Springs Dam.

Flows in the Russian River from Healdsburg to its mouth at Jenner are managed in much the same manner as the Russian River above Healdsburg. Lake Sonoma water supply releases operate under the general rule of discharging water necessary to satisfy demands (mostly SCWA's) between Dry Creek and the Hacienda gage, and to meet the minimum flow requirement at Hacienda. Under current demands, during *normal* water supply



	1/1	2/1	3/1	4/1	5/1	6/1
CRITICALLY DRY	<4,000	<20,000	<45,000	<50,000	<70,000	<75,000
DRY	<8,000	<39,200	<65,700	<114,500	<145,600	<160,000
NORMAL	>8,000	>39,200	>65,700	>114,500	>145,600	>160,000

Figure 3-3 D1610 Russian River Basin Streamflow Requirements

conditions in the summer, releases from Lake Sonoma are typically controlled by the required minimum flows in Dry Creek and the lower Russian River. During *dry* and *critically dry* summers, releases are often controlled by water supply needs.

During the winter months, USACE controls releases from Coyote Valley Dam and Warm Springs Dam to provide flood protection to downstream areas. In doing so, USACE captures high flows during high runoff events and releases these flows at a lower magnitude over a longer period. The two dams control runoff from a relatively small proportion of the watershed, so winter river flows are largely governed by local runoff from unregulated tributary streams. Winter flow levels are typically much higher than summer flow levels.

3.4.2 Operational Considerations in Flow Regulation

For the purpose of managing water supply releases from Lake Mendocino and Lake Sonoma, the river can be evaluated in two sections: 1) the Russian River between Lake Mendocino and Healdsburg; and 2) the Russian River from Healdsburg to Jenner, including Dry Creek.

SCWA must release enough water from Lake Mendocino and Lake Sonoma to meet downstream water demands, and ensure that releases are adequate to meet minimum flow requirements in the Russian River and Dry Creek. Several factors affect the amount and timing of water supply releases. These factors include the length of time it takes water to travel from the reservoirs to downstream monitoring points, changes in weather, and variability in water demands and diversions. SCWA does not control diversions other than those made at its diversion facilities.

Under D1610 during *normal* water supply conditions in the summer, minimum flows in the mainstem Russian River are 185 cfs at the confluence of the East Fork and 125 cfs at Guerneville. Under current demand during a normal summer, SCWA must release up to 300 cfs, and occasionally more, from Lake Mendocino to satisfy demand and meet the 185-cfs minimum flow requirement at Healdsburg. Because a change in release at Lake Mendocino may take up to 3 days to appear at Healdsburg (SCWA 1999a), SCWA maintains an operational margin of 10 to 20 cfs above the release necessary to meet the minimum flow requirement (taking into account non-SCWA diversions). This provides the buffer necessary to ensure that, as water use and diversions fluctuate, the minimum flow requirements will be met. To determine the effects of adjustment to the release, SCWA must allow downstream flows to stabilize before making additional modifications to the releases.

Under D1610, minimum flows were established for the reach of Dry Creek between Warm Springs Dam and the confluence with the Russian River to assure fish passage during upstream spawning runs and downstream migrations. Required minimum flows are determined by water supply condition (see Figure 3-3). Under baseline conditions, actual summer flows in Dry Creek are largely determined by water demand.

3.4.3 Modeling of Flow and Temperatures

SCWA has modeled D1610 flow and water temperature using the Russian River System Model (RRSM) (Flugum 1996) and the Russian River Water Quality Model (RRWQM) (RMA 2001). These models were used to simulate the flow and water quality conditions that would exist under current and projected future (buildout) water demand conditions. Flow was modeled for each of four locations on the upper (Ukiah), middle (Cloverdale and Healdsburg), and lower (Hacienda) Russian River and on Dry Creek (Figure 1-1). The upper Russian River is represented by the Ukiah and Hopland nodes within the model (Table 3-7). The middle Russian River is represented by the Cloverdale and Healdsburg nodes. The lower Russian River is represented by a node in the Russian River downstream of the confluence of Dry Creek (Below Dry Creek) and at the Hacienda near Guerneville (Hacienda). The Hacienda node also estimates inflow to the Estuary.

Table 3-7 Location of Nodes Used to Model Flow in the Russian River and Dry Creek

River Reach	Model node
Upper Russian River	Ukiah
	Hopland
Middle Russian River	Cloverdale
	Healdsburg
Lower Russian River	Below Dry Creek
	Hacienda
Dry Creek	Warm Springs Dam
	Lower Dry Creek

Dry Creek is represented by two nodes: one downstream of Warm Springs Dam (Warm Springs Dam) and one upstream of the Healdsburg diversion (Lower Dry Creek).

The mean daily flows that were equaled or exceeded 50 percent of the time (50 percent exceedance flows) are presented for *all* water supply conditions combined and for *dry* water supply conditions. *All* water conditions represent the full 90-year period (1910 to 2000) simulated in the RRSM, including *dry* and *critically-dry* water supply conditions. *Dry* water supply conditions within this document combine *dry* and *critically dry* water supply conditions (Table 3-8).

3.4.4 Projected Flows under D1610

3.4.4.1 Current Demand Levels

Under current water demand levels and *all* water supply conditions, the median flows from June through October range from approximately 164 to 261 cfs in the middle and upper Russian River (Table 3-8). Because of diversions, losses to groundwater and evaporation, flows decline with distance downstream from the Forks from July through October. From Dry Creek to Mirabel, flows are higher due to the inflow from Dry Creek, ranging from 246 to 320 cfs. At Hacienda, flows are again lower, primarily due to diversions at SCWA's Mirabel facilities. These flows are more similar to those in the upper Russian River, ranging from 148 to 279 cfs. During the winter months flows increase with distance downstream from Coyote Valley Dam due to inflows from unregulated tributaries. The median flows from November through May range from approximately 170 cfs to 2,200 cfs in upper and middle Russian River and from approximately 275 cfs to 3,900 cfs at Hacienda.

Under current demand levels and *dry* water supply conditions, the median flows from June to October range from 89 to 177 cfs in the upper and middle Russian River. Between the confluence of Dry Creek and Mirabel, flows range from 186 to 206 cfs. At Hacienda, flows range from 92 to 102 cfs from June to October. During the wet season (November to May) median flows range from 113 cfs to approximately 1,200 cfs in the upper and middle Russian River, while flows at Hacienda range from 156 to 1,824 cfs.

In Dry Creek under *all* water supply conditions at current demand levels, the median flows range between 81 cfs and 103 cfs from June to October. During this period, flows are typically lower at the lower end of Dry Creek. Flows typically increase during November to May, and the median flows range between 76 cfs and 482 cfs. During November to May, Dry Creek is typically a gaining reach due to tributaries inflow, and flows in lower Dry Creek are higher than those below Warm Springs Dam. Under *dry* water supply conditions in Dry Creek, median flows during June to October range between 77 cfs and 129 cfs. The winter and spring flows range between 26 cfs and 150 cfs.

3.4.4.2 Buildout Demand Levels

Under Buildout demand Levels, the RRSM predicts that flow levels under *all* water supply conditions during June to October will range from 164 to 273 cfs in the Upper and Middle Russian River, which is very similar to flows under current demand levels. Between the confluence of Dry Creek and Mirabel, flows would increase, as the increased water demand would be met through increased releases from Lake Sonoma. Flows in this section of the river would range from 260 to 330 cfs. At Hacienda, flows would be lower than under current demands, ranging from 137 to 202 cfs. During November to May, flows at Ukiah would range from 173 to 925 cfs, while flows at Hacienda would range from 228 to 3,654 cfs.

Under *dry* water supply conditions under buildout demand levels, flows from June through October would range from 109 to 195 cfs at Ukiah, with flows decreasing with distance downstream of the Forks to the confluence of Dry Creek. Between the mouth of Dry Creek and Mirabel, flows would range from 220 to 304 cfs, as much of the demand served by SCWA's facilities would be met out of Lake Sonoma. At Hacienda, flows would range from 93 to 100 cfs from June to October. During the wetter portion of the

Table 3-8 Median Daily Flows (cfs) in the Russian River and Dry Creek for D1610

Current Demand Level

All Water Supply Conditions

Stations	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
Ukiah	736	927	516	602	304	235	261	231	179	173	167	348
Hopland	844	1095	624	683	323	233	250	222	174	170	167	389
Cloverdale	1084	1404	853	831	365	232	234	209	167	168	171	461
Healdsburg	1632	2182	1418	1196	500	237	208	200	164	169	183	598
Below Dry Creek	2016	2950	1970	1450	606	320	292	282	246	248	295	753
Hacienda	2595	3867	2656	1796	702	279	197	174	148	163	276	865
Below Warm Springs Dam	76	278	255	134	81	95	103	93	85	81	106	106
Lower Dry Creek	200	482	368	196	92	87	89	87	84	83	111	135

Dry Water Supply Conditions

Stations	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
Ukiah	148	570	275	238	173	176	177	119	114	106	113	153
Hopland	186	633	356	273	175	165	162	111	107	102	114	177
Cloverdale	263	778	535	326	189	151	141	99	96	98	123	239
Healdsburg	440	1182	838	442	217	112	98	89	89	95	127	335
Below Dry Creek	579	1382	1062	499	250	195	205	206	201	186	206	425
Hacienda	725	1824	1496	572	249	102	92	95	96	96	156	430
Below Warm Springs Dam	76	76	76	26	26	88	129	127	117	91	76	76
Lower Dry Creek	110	150	146	53	38	77	114	121	115	91	79	96

Buildout Demand Level

All Water Supply Conditions

Stations	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
Ukiah	705	925	514	599	306	242	273	240	185	177	173	340
Hopland	812	1081	617	678	326	237	259	229	179	174	176	385
Cloverdale	1046	1398	851	827	364	235	239	214	171	171	183	462
Healdsburg	1580	2128	1387	1175	478	237	209	200	164	170	178	587
Below Dry Creek	1891	2752	1892	1427	584	330	328	323	279	260	288	754
Hacienda	2482	3654	2543	1739	611	202	139	139	137	140	228	842
Below Warm Springs Dam	76	158	208	115	81	104	139	143	126	89	106	106
Lower Dry Creek	195	382	328	184	94	95	118	129	118	92	111	138

Dry Water Supply Conditions

Stations	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
Ukiah	149	534	279	231	194	195	195	129	123	109	110	143
Hopland	176	595	363	257	194	180	177	120	114	105	113	145
Cloverdale	226	730	539	308	202	153	149	104	101	100	122	158
Healdsburg	392	1141	809	411	227	113	100	90	90	96	112	203
Below Dry Creek	533	1325	1023	462	298	266	304	286	248	220	208	296
Hacienda	652	1733	1363	510	202	96	93	97	100	93	127	308
Below Warm Springs Dam	76	76	76	26	26	172	236	217	171	124	82	76
Lower Dry Creek	110	144	144	56	48	153	213	203	162	125	97	114

year under *dry* water supply conditions flows at Ukiah would range from 110 to 534 cfs, with higher flows with increasing distance downstream of the Forks due to accretion from tributaries. At Hacienda, flows during this time of year would range between 127 and 1,733 cfs in *dry* water supply conditions.

In Dry Creek, flows would increase during the summer months, as most of the increased demand would be met through additional releases from Lake Sonoma. From June to October, flows would range from 89 to 143 cfs under *all* water supply conditions, and from 124 to 236 cfs under *dry* water supply conditions. From November to May, flows would range from 76 to 382 cfs under *all* water supply conditions and from 26 to 144 cfs under *dry* water supply conditions.

3.4.5 PROJECTED WATER TEMPERATURES UNDER D1610

Temperatures generally increase with distance below the two dams from March through September under both water supply conditions. During October through February, water temperatures are generally constant or decrease slightly with distance below the dams.

RRWQM simulations indicate that temperature conditions in the Russian River and Dry Creek would generally be within a suitable range for salmonids from November through April, but would be very stressful for salmonids below Healdsburg during July and August (Table 3-9).

3.4.5.1 Current Demand Levels

Under current water demand levels and *all* water supply conditions, median monthly temperatures range from 15.8°C to 19.8°C at Ukiah from June through October. Temperatures become warmer with distance downstream from the Forks. Temperatures are slightly stressful at Cloverdale, during this time period, ranging from 18.1°C to 20.5°C. At Healdsburg, temperatures are generally stressful, ranging from 18.6°C to 23.6°C, and are very stressful in July and August, when water temperatures exceed 23°C. Water temperatures are moderated somewhat by the influence of flows from Dry Creek, but remain warm, exceeding 22°C in July and August. At Hacienda, water temperatures again exceed 23°C in July and August and range between 18.3°C and 23.5°C between June and October. From November through May, water temperatures are cooler, ranging from 8.6°C to 15.1°C at Ukiah and 9°C to 18.4°C at Hacienda.

In *dry* water supply conditions under current demand levels, temperatures are similar (within 0.5°C) to those under *all* water supply conditions from November through July. In August through October, water temperatures in the upper Russian River are cooler by 1 to 1.5°C. This cooling is observed downstream to Cloverdale, but is not evident at Healdsburg. Below the mouth of Dry Creek, cooler temperatures are again evident during the summer months due to higher releases from Warm Springs Dam. This cooler water is not observed at Hacienda, however, except in July.

In Dry Creek, water temperatures are similar below the dam regardless of water supply condition, ranging from 12°C to 13.3°C throughout the year. During April through

Table 3-9 Median Temperatures in the Russian River and Dry Creek under D1610

Current Demand Level

All Water Supply Conditions

Stations	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
Ukiah	8.6	9.3	11.3	12.6	14.4	15.8	16.1	18.1	19.8	19.7	15.1	10.7
Hopland	8.6	9.4	11.7	13.4	16	18	18.5	19.7	20.4	19.3	14.8	10.6
Cloverdale	8.5	9.4	11.9	14	16.9	19.1	19.9	20.5	20.4	18.9	14.7	10.5
Healdsburg	8.5	9.8	12.6	15.6	19	21.8	23.6	23.3	21.6	18.6	14.3	10.1
Below Dry Creek	8.8	10.1	12.7	15.5	18.8	21.2	22.6	22.2	20.5	17.7	13.9	10.4
Hacienda	9	9.9	12.2	15	18.4	21.4	23.5	23.4	21.6	18.3	14	10.6
Warm Springs Dam	12.4	11.8	12.8	12.9	13	13.2	13.2	13.1	13.1	12.9	12.7	12.7
Lower Dry Creek	10.3	10.9	13	14.7	16.7	17.8	18.3	17.9	16.8	15.1	13.1	11.6

Dry Water Supply Conditions

Stations	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
Ukiah	9.4	9.5	11.4	13.3	14.9	15.4	15.5	17	17.4	18	15.2	11.2
Hopland	9.7	9.7	11.9	14.5	16.7	18.1	18.4	19.5	19.1	18.1	14.8	11
Cloverdale	9.7	9.7	12	14.7	17.3	19	19.9	20.3	19.5	18.2	14.6	10.8
Healdsburg	9.4	10	12.7	16	19.4	21.7	23.8	23	21.3	18.5	13.9	10.1
Below Dry Creek	9.8	10.2	12.8	16	19.1	20.9	21.3	20.4	19	17.3	13.6	10.2
Hacienda	9.6	10	12.2	15.2	18.6	21.6	23.6	22.7	21	18.2	13.6	10.4
Warm Springs Dam	12.7	12.7	12.8	13.1	13.2	13.2	13.1	13.1	13	12.9	12.8	12.7
Lower Dry Creek	11.2	11.3	12.9	15.4	17.4	17.9	17.6	17	16.1	15.1	13.1	11.4

Buildout Demand Level

All Water Supply Conditions

Stations	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
Ukiah	8.5	9.2	11.3	12.6	14.4	15.8	16.4	18.6	20.8	19.8	14.9	10.4
Hopland	8.5	9.4	11.7	13.4	16	17.9	18.6	20	21	19.3	14.6	10.3
Cloverdale	8.4	9.4	11.9	14.1	16.9	19.1	20	20.8	20.8	18.9	14.6	10.2
Healdsburg	8.5	9.8	12.6	15.6	19	21.8	23.6	23.4	21.7	18.6	14.2	10
Below Dry Creek	8.8	10.1	12.7	15.5	18.8	21.1	22.1	21.5	19.9	17.4	13.8	10.3
Hacienda	8.9	9.9	12.2	15	18.3	21.2	23.3	23.1	21.2	18.1	14	10.5
Warm Springs Dam	12.5	12	12.8	12.9	13	13.2	13.3	13.1	13	12.8	12.8	12.7
Lower Dry Creek	10.3	10.9	13	14.7	16.7	17.6	17.7	17	16.2	15	13.1	11.6

Dry Water Supply Conditions

Stations	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
Ukiah	9.3	9.4	11.4	13.2	14.7	15.3	15.8	18.1	19.9	19	15	10.9
Hopland	9.6	9.6	11.8	14.4	16.5	17.9	18.7	20.1	20.4	18.6	14.6	10.9
Cloverdale	9.6	9.7	11.9	14.7	17.2	18.9	19.9	20.7	20.1	18.3	14.5	10.7
Healdsburg	9.4	10	12.7	16.1	19.3	21.6	23.7	23	21.4	18.5	13.9	10.1
Below Dry Creek	9.8	10.2	12.8	16	18.8	19.6	19.6	19	18.3	16.7	13.5	10.2
Hacienda	9.6	9.9	12.1	15	18.4	21	22.7	21.9	20.5	18	13.6	10.4
Warm Springs Dam	12.7	12.7	12.8	13	13.2	13.2	13.1	13	13	12.9	12.8	12.7
Lower Dry Creek	11.2	11.2	12.9	15.4	17.1	16.8	16.6	16.2	15.6	14.7	13	11.4

October, this water warms as it moves downstream, with the highest predicted temperatures being 18.3°C in July under *all* water supply conditions and 17.9°C in June under *dry* water supply conditions. Water temperatures during July through September at the downstream end of Dry Creek are generally 0.7°C to 0.9°C cooler during *dry* water supply conditions than during *all* water supply conditions, due to higher release flows.

3.4.5.2 Buildout Demand Levels

Under buildout demand levels under both *all* and *dry* water supply conditions, water temperatures in the upper and middle Russian River are generally quite similar to those under current demand levels during all months. This is because the additional water needed to meet the increased demand is drawn from Lake Sonoma. Below the confluence of Dry Creek, water temperatures are 0.5°C to 1.7°C cooler than under current demand levels from July through September for both water supply conditions. At Hacienda, temperatures are again similar to those under current demand levels under *all* water supply conditions, ranging from 18.1°C to 23.3°C. Under dry water supply conditions, water temperatures at Hacienda remain 0.5°C to 0.8°C cooler during June through September under buildout demand levels than were predicted based on current demand levels.

Under the buildout demand levels in Dry Creek under both water supply conditions, water temperatures below Warm Springs Dam are similar to those under current demand levels. In the lower portion of Dry Creek, water temperatures are up to 0.9°C cooler during July and August than under current demand levels and *all* water supply conditions, ranging from 17°C to 17.7°C. In *dry* water supply conditions, water temperatures during June through October range from 14.7°C to 16.8°C, about 0.4°C to 1.1°C cooler than under current demand levels.

3.4.6 Effects of D1610 Flows on Listed Salmonids

A summary of effects is provided below. Additional discussion of the effects of D1610 operations are provided in Section 5.3 of this report. The results below are provided by lifestages for all three species. Generally, these lifestages occur during the same portions of the year, but some notable exceptions do occur and these are discussed separately.

The operations of Lake Mendocino and Lake Sonoma generally store water in the winter and augment flows in the summer. In most years, these operations generally result in only small changes during the wet winter period when many important life-history activities occur, such as upstream passage, spawning, incubation, and downstream passage of salmonids. Flows during the summer period are augmented by water supply deliveries. Under the D1610 at the projected buildout demand levels, Coyote Valley Dam flow releases remain similar to those under current demand levels under *all* water supply conditions, but are somewhat higher under *dry* water supply conditions. Under buildout demand levels, flows in Dry Creek are substantially increased from June through October under both *all* and *dry* water supply conditions.

In general, water temperature is usually good to excellent for salmonids from November through April. Summer and fall have high water temperatures that may be sub-optimal, particularly in the middle and lower Russian River. The upper Russian River generally has good temperature conditions even during the summer period. During the summer months, water temperatures in Dry Creek are markedly better than those in the Russian River and are generally at optimal or slightly cooler than optimal levels near Warm Springs Dam.

Upstream Passage

Flows under D1610 at current demand levels are generally suitable for upstream passage throughout the Russian River and Dry Creek under *all* water supply conditions. Under *dry* water supply conditions, upstream passage for coho and Chinook salmon may be impaired about a third of the time due to low flows. The model results showed the impairment extending through most of the migration season for coho and Chinook salmon. Steelhead migrate later in the season and had poor passage conditions approximately 25 percent of the time, mostly in January. During periods of impeded passage, upstream migration may be possible during and following storm events. Migration up Dry Creek appears to be unimpeded in *all* and *dry* water supply conditions.

Under the buildout demand levels, D1610 flows would be more restrictive for Chinook than under current demand levels in the early part of their migration season in *dry* water supply conditions due to the lower flows that occur in the Upper and Middle Russian River. These lower flows may extend into the early part of the coho migration season, and therefore may affect their migration opportunities as well. Flows are generally higher by December, so coho salmon would have migration opportunities in December and January, and steelhead upstream migration would be largely unaffected.

Warm water temperatures may be present during the early portion of the upstream migration season for Chinook salmon. Some Chinook salmon migrates as early as mid August. Water temperatures are stressful for adult Chinook salmon from August through October. The majority of Chinook migrate in November (Chase 2000, 2001). Later, between December through February, water temperatures are at near optimal levels for upstream migration. Coho salmon have a peak migration period during the time when water temperatures are more acceptable. Steelhead migrate upstream later in the season, and therefore experience cooler water temperatures which are near optimal for this lifestage. Water temperatures for D1610 at buildout demand levels were similar to those at current demand.

Spawning and Incubation

Spawning and egg incubation generally occurs from November through May, with the exact timing depending on the species. The peak of coho and Chinook salmon spawning occurs in November and December, while the peak of steelhead spawning occurs in February or March. Steelhead and Chinook spawn in the mainstem in the Middle and Upper reaches of the Russian River (although steelhead rely primarily on tributaries for spawning and rearing), and all three species spawn in Dry Creek. Flows under both *all* and *dry* water supply conditions appear to provide suitable habitat for spawning and incubation of steelhead and Chinook salmon in the Middle and Upper reaches of the mainstem.

Flow conditions in Dry Creek for spawning and incubation are very stable regardless of the water supply condition. These life-history activities do well under stable flow conditions. Dry Creek provides suitable spawning and incubation habitat for all three species under current demand levels. Under buildout demand levels, flows in Dry Creek under *all* water supply conditions and *dry* water supply conditions provide similar spawning and incubation conditions.

Under current demand levels, water temperatures in the mainstem are generally good for Chinook salmon and steelhead spawning and incubation. However, temperatures may become stressful for steelhead during the latter part of their incubation season (April and May) in the Middle Reach. Temperatures are generally suitable for spawning and incubation for all three species on Dry Creek. Under buildout demand levels, temperatures remained largely unchanged from those under current demand levels.

Rearing

Under current demand levels, water velocities in the Upper and Middle Reaches are higher than optimal for rearing salmonids. Optimal conditions occur only 30 to 50 percent of the time. The lower mainstem is not thought to provide substantial rearing habitat during the summer months for these salmonids due to poor habitat conditions and high water temperatures. Under *dry* water supply conditions, flows are lower resulting in improved rearing conditions. At buildout, rearing conditions are similar to those under current demand, with improved habitat in *dry* water supply conditions.

Under current demand levels, summer flows in Dry Creek can be too high for good rearing habitat. The higher flows under *dry* water supply conditions provide poor rearing conditions for all three salmonid. Under buildout demand levels, flows in Dry Creek would be also be increased over flows under current demand levels. This would increase velocities to very unsuitable levels during most of the summer.

Water temperatures in the Middle and Lower reaches of the Russian River are sufficiently high to reduce the potential for steelhead rearing through the summer and early fall. In the Upper reach of the Russian River Creek, temperatures are more suitable, providing good rearing conditions about 60 to 75 percent of the time. Water temperatures in Dry Creek under current demand levels are consistently very good or optimal throughout the summer for the juvenile coho salmon and steelhead rearing (juvenile Chinook salmon have emigrated by this time). Under buildout demand levels, temperatures are similar to those under current demand levels.

3.5 ESTUARY MANAGEMENT

The Russian River Estuary extends 6 to 7 miles from the river's mouth at the Pacific Ocean, near Jenner, upstream to Duncans Mills and Austin Creek in western Sonoma County (Figure 3-4). On occasion, tidal influence has occurred as far as 10 miles upstream to Monte Rio (RREITF 1994). A barrier beach (sandbar) occasionally forms naturally across the mouth of the river during the dry season (and may occasionally form during winter months), impounding water and forming a lagoon. The sandbar opens naturally when hydraulic conditions in the Russian River and Pacific Ocean change, or when it is artificially breached. When the sandbar is open, the Estuary is open to tidal mixing.

Current project operations affect the Estuary primarily in the low-flow months when minimum instream flow requirements under D1610 augment flow to the Estuary. These augmented flows result in a need for an artificial sandbar breaching program to prevent flooding of local property.

3.5.1 CURRENT CONDITIONS AND MANAGEMENT ACTIVITIES

Before SCWA conducted the current breaching program, the Sonoma County Department of Public Works would breach (i.e., open) the sandbar at the mouth of the river to prevent flooding of low-lying areas. On occasion, the sandbar was also breached by local residents. Resource managers became concerned that indiscriminate breaching of the sandbar was affecting the Estuary ecosystem. Following a study of the effects of artificial breaching (RREITF 1994), the Sonoma County Board of Supervisors adopted an Estuary Management Plan. SCWA assumed responsibility for the plan, and began implementing it along with any needed revisions based on monitoring studies. A monitoring program was initiated to evaluate the effects of breaching the sandbar during the period of 1996 to 2000 (Merritt Smith Consulting [MSC] 1997a. 1997b, 1998, 2000; SCWA 2001b).

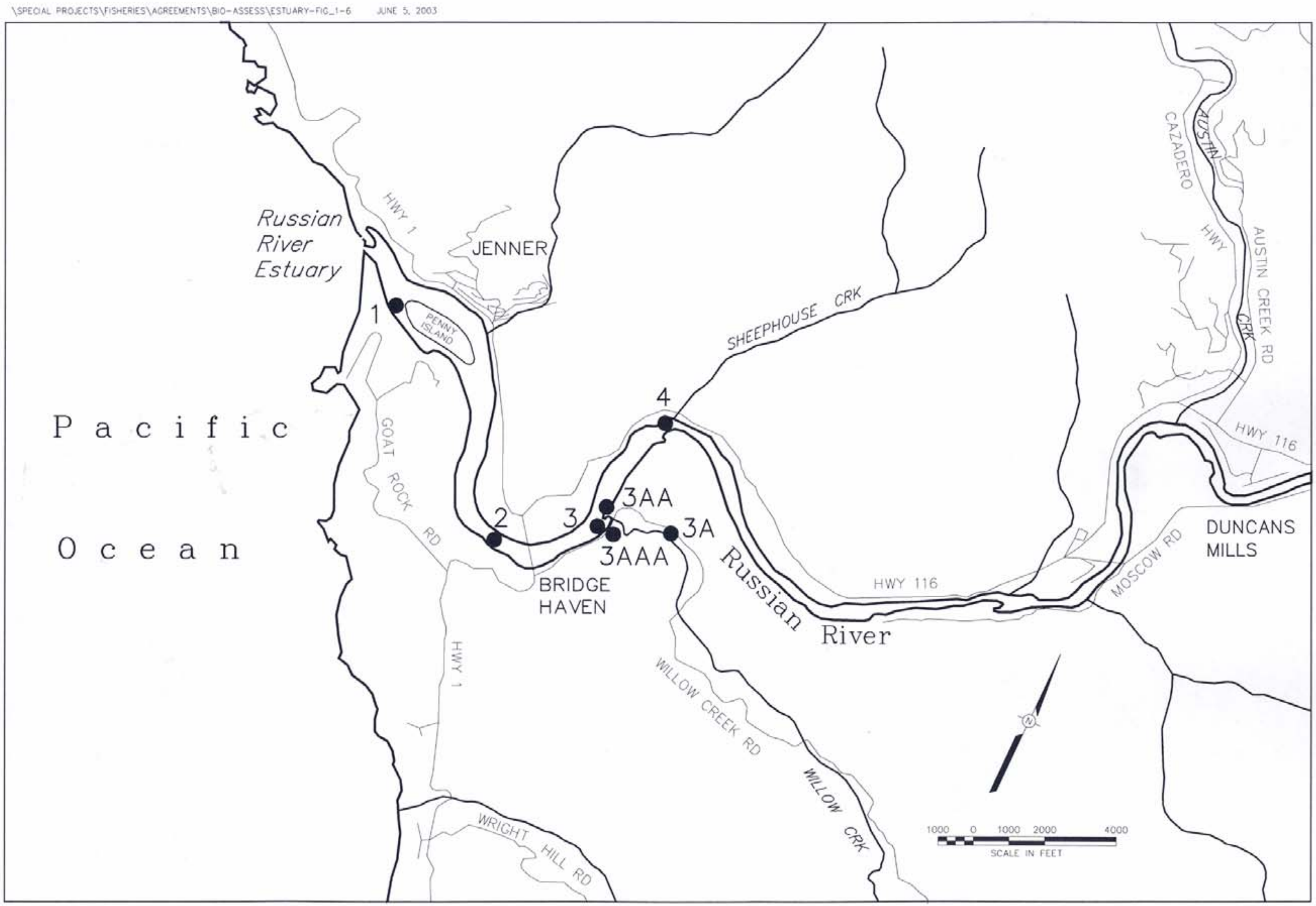


Figure 3-4 Map of Russian River Estuary Showing Biological and Water Quality Monitoring Sample Sites

The current Management Plan for the Estuary includes:

- **Breaching of the Sandbar.** The sandbar is breached when water levels in the Estuary exceed 4.5 feet at the Jenner gage. SCWA's goal is to conduct breaching before the Jenner gage measures 7.0 feet; therefore, breaching is typically conducted when water levels are between 4.5 and 7.0 feet. Water levels are determined from an automated tide recorder. The maximum water elevation was selected to minimize the discharge of anoxic water from Willow Creek Marsh into the Estuary, avoid high flushing velocities caused by high water elevations in the Estuary prior to breaching, and prevent the flooding of property. The breaching schedule varies from year to year depending on the frequency of closure of the Russian River mouth. There is no clear pattern of closures and breachings, but late summer/fall closures are typical.

- **Automated Tide Recorder.** An automated tide recorder has been installed at the Jenner Visitor's Center. Data from the tide recorder are displayed and monitored by remote telemetry at SCWA's Operations Center in Santa Rosa.

Biological and Water Quality Monitoring. Biological and water quality monitoring was conducted before, during, and after four to seven mechanical breaching events per year over a period of 5 years. Because monitoring was tied to breaching events, sandbar-open conditions that may be maintained naturally in the early part of the summer were not monitored. Data were collected at up to seven sample sites in the Estuary (Figure 3-4; Table 3-10). Water quality was also sampled at sites along Willow Creek. At each site, fish and invertebrates were sampled with a seine and otter trawl, while water temperature, DO, and salinity were measured with water quality instruments. Pinniped behavior was monitored at the Russian River mouth by visual observations.

Table 3-10 Water Quality and Fish Sampling Monitoring Locations in 1999 and 2000

Year	Water Quality	Fish Sampling
1999	Datasondes @ Stations 3, 3AA, 4 Profiles @ Stations 1, 2, 3, 3A, 3AA, 3AAA, 4	Beach seines @ Station 1, 3 Otter trawl @ Stations 1, 2, 3, 4
2000	Datasondes @ Station 3, 3A, 3AA Profiles @ Stations 1, 2, 3, 3A, 4	Beach seines @ Stations 1, 3, 4 Otter trawl @ Stations 1, 2, 3, 4

The number of breaching events varies from year to year, depending on the amount of inflow to the Estuary and beach and ocean conditions that determine the frequency of closure of the Russian River sandbar. For most of the years studied, sandbar closures and breachings were generally concentrated in the fall (Table 3-11). Under the current Estuary management, the sandbar is generally closed no more than 7 to 10 days, although it is occasionally closed for longer (MSC 2000).

Table 3-11 Summary of Sandbar Closures and Artificial Breachings, 1996 to 2000

Date Closed	Days Closed	Date Breached	Gage Height[1]	Days Open
1996				
June 29	5	July 5		
July 24	11	August 3[2]		19
August 23	5	August 27[2]		20
		September 8[2]		
September 14	12	September 26		
October 7	8	October 15		
		November 6 (N)[3]		
1997				
March 30	1	March 31		18
April 18	5	April 23 (N)[3]		12
May 2	1	May 3 (N)[3]		12
May 15	7	May 22		11
June 2	7	June 9		7
June 16	11	June 26		44
August 9	10	August 20		19
September 9	10	September 19		7
September 26	3	September 29		4
October 3	8	October 11		15
October 26	8	November 3		4
November 7				
1998				
August 26	4	September 1		6
September 7	5	September 12		1
September 13	1	September 14		9
September 23	5	September 28		7
October 5	3	October 8		7
October 15	4	October 19		4
October 23	4	October 27		1
October 28	1	November 2		
1999				
June 12[4]	3	June 15	7.4	6
June 24	6	July 1	6.3	78
September 17	7	September 23	6.6	2
September 25	8	October 4	7.0	3
October 7	14	October 15, 21[5]	6.7, 7.44	9
November 1	3	November 4(N)[3]	5.7	2
November 6	4	November 10	8.9	3
2000				
May 7	2	May 9	8.46	37
June 16	5	June 21	6.90	67
August 28	8	September 5	7.62	31
October 7	4	October 11	6.54	12
October 24	3	October 27	6.87	7
November 4	3	November 7	6.93	2

Table 3-11 Summary of Sandbar Closures and Artificial Breachings, 1996 to 2000 (Continued)

Date Closed	Days Closed	Date Breached	Gage Height[1]	Days Open
November 10	3	November 13	6.74	7
November 21	3	November 24	7.34	2
November 27	3	November 30	7.73	2
December 3	3	December 6	7.69	20
December 27	2	December 29	7.10	4

[1] Height on tide gage immediately before breaching.
[2] Unauthorized breach by unknown persons.
[3] Natural breach.
[4] Sandbar closed completely on June 12, but was partially closed for at least 9 days before that.
[5] Sandbar was breached October 15, but closed again the following day. Sandbar was breached again on October 21.

3.5.1.1 Water Quality

High water temperature in the lower mainstem Russian River has been considered a factor affecting salmonid rearing habitat. However, below RM 10, coastal fog and other marine influences have a cooling effect on surface water. The coastal river zone may provide better conditions for salmonids than the lower mainstem, including cooler summer temperatures (Winzler and Kelly 1978).

When the sandbar closes the river mouth, it traps saltwater in the lagoon. Because saltwater is denser than fresh water, it forms a layer under the fresh water from the river inflows (stratification), forming a saltwater lens that traps heat. Salinity, temperature, and DO stratification occur within the water column. Through natural processes, DO becomes depleted in the bottom saline layer and anoxic conditions develop.

This process was documented in the Estuary during the 5-year monitoring study. Water quality data were collected before, during, and after artificial breaching events at 1-meter-depth intervals in the water column at sites between the river's mouth and Sheephouse Creek. Water quality profiles were generally taken in the afternoon, so diurnal changes were not recorded.

When the sandbar closed, salinity stratification led to reductions in DO and increases in temperature in the near-bottom layers of deep pools within the first 2 weeks. When the sandbar was breached, tidal mixing contributed to a renewal of DO and reduced temperatures. This process occurred most quickly near the mouth of the river, but took up to several days at upstream sites. The rate of change was influenced by the volume of river flows, whether there was a spring tide or neap tide, and the length of time the sandbar remained open. When the sandbar re-formed, salinity stratification again led to a deterioration of water quality in deep pools.

The deepest pools often remained stratified until an influx of tidal flows or higher winter flows flushed the pools or caused mixing of the stratified layers. Summer breaching of the sandbar draws fresh water through the Estuary and accelerates mixing of stratified layers in the pools, which increases DO at depth. However, flows caused by breaching may not be sufficient to mix saline waters located at the bottom of the deepest pools.

Because the sandbar is breached frequently under the current Management Plan, the duration of low DO and high temperature conditions near the mouth of the river were generally limited to approximately 2 weeks or less. Data from 1999 show that water quality in near-bottom layers of pools was better when the sandbar was open than when it had been closed for a short period of time (2 weeks).

In a pre-breaching survey on June 30, 1999 at water quality monitoring Station 2, surface waters were 24°C; however, in the subsurface layer, with a very high DO spike (likely related to photosynthetic plants), water temperatures were cooler, between 15 and 20°C (MSC 2000). Therefore, the best fish habitat would have occurred in this subsurface layer. A survey on July 6 during tidal conditions revealed a similar temperature and salinity profile, but DO was more uniform from surface to bottom at levels between approximately 6 and 8 mg/l, increasing the portion of the water column that had suitable habitat conditions for salmonids.

At water quality monitoring Station 3 at the mouth of Willow Creek, temperatures in the near-bottom layer of the monitored pool were suitable when the sandbar was open, and DO levels fluctuated, generally increasing during spring tides and decreasing during neap tides (MSC 2000). After the sandbar closed on October 7, 1999, DO decreased steadily from 6 to 7 parts per million (ppm) during a 14-day closure, and anoxia was reestablished in the bottom layers of the pool by October 18 (within 11 days). During two brief November closures (3 and 4 days long), DO levels declined, from approximately 5 ppm to very low levels, but anoxic conditions did not form in the near-bottom layer.

In contrast, at water quality monitoring Station 4, the most upstream monitoring site, near-bottom anoxia was not relieved until 5 days after a June 15 breaching. This occurred during neap tides at a river flow of 260 cfs. When the sandbar closed on June 24, near-bottom DO gradually declined during a 6-day closure, and continued to decline for several days after the July 1 breaching. Highest DO values were usually associated with spring tides (MSC 2000).

Salinity levels of approximately 30 ppt have been recorded as far upstream as Sheephouse Creek, approximately 3.1 miles upstream of the river mouth. Salinity at this level is similar to ocean water.

This study only monitored water quality during short periods of sandbar closure. If the lagoon were to stay closed and there was sufficient freshwater inflow, the lagoon would be expected to convert to fresh water, water quality would improve, and fluctuations in habitat conditions would be eliminated.

Datasondes (instruments used to record hourly temperature, salinity, and DO) were deployed on the bottom of deep pools in the Estuary and in Willow Creek throughout the study season to characterize water quality through the summer (Figure 3-4). The data show that, when the sandbar remains open, water quality is generally better in the near-bottom layers than when it has been closed for a short time (MSC 1997a, 1997b, 1998, 2000; SCWA 2001b). It should be noted that datasonde monitoring may give a general assessment of water quality changes in these deep pools, but does not assess the extent of microhabitat elsewhere that may provide refugia for salmonids.

Water quality is affected by the schedule of artificial breaching, but is not completely determined by it. The renewal of DO in the saline near-bottom layers of deep pools is mediated by both river flow and tidal action (spring/neap cycle) as well as by post-breaching flushing (MSC 2000). While low DO in the near-bottom layers of the deep pools is associated with sandbar-closed conditions, anoxia can also develop under tidal conditions during neap tides and/or low river flows (MSC 2000).

3.5.1.2 Biological Resources

A total of 43 species of fish were collected in the Estuary during the 5 years of the monitoring study (MSC 1997a, 1997b, 1998, 2000; SCWA 2001b). Commonly captured estuarine/marine species included topsmelt, Pacific sanddab, starry flounder, staghorn sculpin, prickly sculpin, threespine stickleback, and shiner surf perch (see Table 2-6). The distribution of marine fish is limited to the lower Estuary below the Willow Creek mouth, with the most salt-tolerant species found only near the Russian River mouth.

Commonly captured freshwater fish included Sacramento sucker, Sacramento pikeminnow, and California roach. These species tend to move down into the Estuary during the summer and return upstream in the fall. Macroinvertebrate species commonly captured in otter trawls included opossum shrimp (*Neomysis mercedis),* bay shrimp (*Crangon franciscorum*), dungeness crab (*Cancer magister*), amphipods (*Eogammarus confervicolus*), and spaeromatid isopods (SCWA 2001b).

The upper portions of the Estuary (Duncans Mills to Sheephouse Creek), which have not been sampled, are important for juvenile-rearing salmonids, especially because the coastal fog belt moderates high water temperatures in the summer. Data from the Mirabel sampling program indicate that naturally-spawned juvenile Chinook salmon migrate down the Russian River in the spring (Chase et al. 2000). Fall-run Chinook have been known to rear in estuaries before migrating to the ocean (Kjelson et al. 1982), and may rear for a time in some part of the Estuary. The tributaries in the lower Russian River contain high-quality steelhead spawning and rearing habitat. Although steelhead rear in fresh water throughout the year, they have been caught in the Estuary and may make use of suitable portions of the Estuary (MSC 2000).

Biological sampling, which has been conducted around artificial breaching events, has been largely concentrated in fall months, and therefore was not designed to assess how salmonids may use the Estuary throughout the year. In 1997, when fish sampling occurred earlier in the year, steelhead were captured throughout the summer, and 3-year classes appeared to be represented (MSC 1997a). Steelhead were captured during all 5 years sampled. Chinook salmon were captured in 1992, 1993, 1997, and 1999 in the early spring when migration occurs (RREITF 1994; SCWA 2001b). Coho salmon also pass through the Estuary, but have not been captured during sampling for the Management Plan. Most adult salmonids migrate up the Russian River during the period when the mouth is naturally open, usually late fall to early spring.

Pinnipeds use the sandspit at the river mouth as a haulout and to forage for fish, which may include listed salmonids. Harbor seals, sometimes numbering in the hundreds, regularly use the Russian River mouth year-round, while California sea lions and elephant seals occur periodically in low numbers. Harbor seal numbers peak in the late winter and mid-summer and prefer to use the river's mouth when it is open.

The capture rate of salmonids by seals may be affected by the width of the breach opening and river flows during fish migration periods. A mechanical breach with a wide opening and ample flows increases passage for outmigrating juveniles and returning adults through the river mouth, and may reduce the potential for seals to capture salmonids. Seals have been observed foraging in the Estuary, and are more successful at capturing fast-moving prey, such as salmonids, if they can take advantage of trapped or stressed fish. In 1992, outmigrating juvenile salmonids consisted of 17 percent of the prey items of harbor seals when the mouth was closed, compared with 5 percent when the Estuary was open (RREITF 1994). However, this predation rate may not have been representative of typical conditions. Prior to the predation study, rainfall had increased flows in the Russian River, the sandbar and the river mouth had closed the Estuary, and 36,000 salmonid smolts were released from the DCFH upstream of the Estuary. Since this time, smolts are released from DCFH between December and April over a 3-day period during new moon phases, with the majority of fish being in February and March. The Estuary is generally open during this time.

3.5.1.3 Willow Creek

In 1992, a fish (prickly sculpin) and invertebrate (mysid) kill at the mouth of Willow Creek was associated with a flush of anoxic water from Willow Creek following a sandbar breach after water levels reached over 9 feet (RREITF 1994). This type of event has not occurred during the 5 years of monitoring the Estuary. Mortality of prickly sculpin in 1998, associated with a breaching event after water levels rose to 8.2 feet, may have been caused by low DO in water draining from Willow Creek, but no anoxia was detected (MSC 1998). Dead dungeness crabs were found in 1999 near the mouth of Willow Creek, but this was most likely due to a flush of fresh water after an artificial breaching event (MSC 2000).

The 1992 and 1998 high-mortality events were associated with breaching that occurred at over 9.0 feet and 8.2 feet, respectively. Artificial breaching associated with water levels lower than 8.0 feet did not result in similar events. When water levels were greater than 8 feet, near-bottom DO levels at the monitoring sites became anoxic within a few days of sandbar closure. Currently, artificial breaching is initiated when the water level reaches 7 feet at the Jenner gage, to reduce the risk of flushing anoxic water from Willow Creek.

The 1992 event was believed to occur because a large area of Willow Creek marsh was inundated and then became anoxic due to low water inflow and high biological oxygen demand (BOD) (RREITF 1994). Another explanation could be that, when the sandbar is breached at higher water surface elevations, higher flushing flows are more likely to discharge bottom waters, and sediments containing low DO levels.

3.5.2 Factors Affecting Species Environment within the Estuary

The Estuary is important for adult and juvenile passage for all three listed species. When juvenile salmonids become smolts, they undergo a physiological change that allows them to make a transition from fresh water to salt water. An estuary provides an opportunity for smolts to gradually become acclimated to ocean conditions before their migration out of the river system. Estuaries and lagoons can also provide important rearing habitat for steelhead and Chinook salmon, and possibly for coho salmon.

Under D1610 flow conditions, the system is generally managed as an estuary (sandbar open) rather than a lagoon (sandbar closed), to prevent flooding of local property. Augmented summer flows have the potential to affect several components of salmonid habitat in the Estuary. These include water quality (including temperature, DO, and salinity), primary productivity and the availability of aquatic invertebrates, availability of shallow-water habitat, and the concentration of nutrients and toxic runoff. The breaching program directly affects these components.

The artificial breaching program has the potential to affect adult salmonid upstream migration and juvenile downstream migration by creating additional passage opportunities. Since adult Chinook salmon congregate at the mouth of the river as early as late August, artificial breaching is of particular concern for this species. If the sandbar is breached before rising river flow from winter storms improves water quality in the mainstem Russian River, adult Chinook salmon may become trapped in poor quality water. The risk of predation on listed fish species may be slightly increased when migrating juvenile salmonids are concentrated into a channel through the sandbar, and when pinnipeds are attracted to the breached sandbar.

Estuaries and coastal lagoons have been found to provide important salmonid rearing habitat in coastal lagoons in the southern portion of the CCC steelhead ESU (Smith 1990) and elsewhere (Larson 1987; Anderson 1995, 1998, 1999; Reimers 1973). If the sandbar of one of these central California estuaries remains open, good water quality can be maintained with tidal mixing or high river flows. In a lagoon (sandbar closed), water quality initially decreases in the short-term, but suitable water quality develops when the system is converted to fresh water, which results in lower water temperatures and higher bottom-DO levels. Some of the best rearing habitat can develop under these conditions (Smith 1990). Infrequent breaching of these lagoons, particularly during low-flow summer months, impairs water quality because, each time the sandbar reforms, there is a long transition period with salinity stratification, which results in high water temperatures and low DO levels (Smith 1990). If summer inflow to the lagoon is low, the lagoon may not freshen again for the remainder of the season. After the sandbar opens, there is a period of rapid transition when habitat and water quality changes dramatically. After these transition periods, the flora and fauna of the estuary undergo dramatic changes in response to the changed environment.

Rapid or fluctuating changes in salinity and water level in small coastal lagoons can have substantial effects on the invertebrate foodbase for fish. Smith (1990) found that when sandbar formation resulted in anoxic conditions over the majority of the substrate, amphipods were eliminated from those areas, and invertebrate populations crashed as the lagoons went through the transition to fresh water. Once these lagoons had converted to freshwater conditions, invertebrate populations became sufficiently re-established to result in accelerated salmonid growth. Continuous breaching, such as occurred at San Gregorio lagoon in the summer of 1986, resulted in low overall invertebrate populations as the system fluctuated between anoxic saline and freshwater conditions.

Sandbar breaching may also influence habitat and water quality in Willow Creek marsh. Water quality monitoring showed that DO in the marsh decreased following sandbar closure, possibly because terrestrial vegetation becomes submerged and begins to decay, increasing BOD during a time when water flow into the marsh is insufficient to renew DO levels. Fluctuating water levels may create conditions that are different from those that would be found in a stable marsh, where aquatic vegetation has time to establish and renew DO in the wetted portions of the marsh.

Augmented flow in the Russian River Estuary has several beneficial effects. It may slow the development of poor water temperatures and DO levels after the sandbar closes. Agricultural and urban runoff from the watershed may increase nutrient loads and chemical levels in the Estuary. Augmented summer flows help to dilute these constituents and carry them out of the Estuary when it is open.

The present need to breach the Estuary in the dry season reduces the value of the Estuary for rearing. Summertime breaching causes repeated changes in habitat conditions (depth, salinity, temperature, and DO) in the Estuary that reduce the beneficial effects. While salmonids are highly mobile and can move away from these areas, most of their foodbase is not as mobile and may experience population fluctuations during repeated breachings. The reduction of this foodbase may thereby reduce the suitability of the Estuary for juvenile salmonids.

3.6 CHANNEL MAINTENANCE

SCWA conducts channel maintenance activities in the Russian River and its tributaries for the purposes of flood and erosion control. The locations of channel maintenance areas on the Russian River are shown in Figure 3-5. SCWA's scope of responsibilities in the Sonoma County portion of the Russian River watershed include activities related to the Central Sonoma Watershed Project and the Mark West Creek watershed, portions of various channels near the cities of Healdsburg, Windsor, Santa Rosa, Pohnert Park, Cotati, and Sebastopol; and USACE dams on the East Fork Russian River (Coyote Valley Dam) and Dry Creek (Warm Springs Dam).

The activities implemented by SCWA for flood control purposes in the Central Sonoma Watershed Project and Mark West Creek watershed include sediment removal, channel debris clearing, vegetation maintenance, and bank stabilization. The Zone 1A flood control zone is shown in Figure 3-6. SCWA channel maintenance activities include the following:

1. Channel maintenance within the Central Sonoma Watershed Project and Mark West Creek watershed.

2. Russian River

   a. Channel maintenance related to the construction and operation of Coyote Valley Dam.

   b. Channel maintenance related to USACE-identified and -constructed flood and erosion control sites (federal sites).

   c. Channel maintenance related to Public Law 84-99 sites (nonfederal sites).

   d. Debris removal as necessary to protect life and property.

3. Dry Creek channel maintenance related to the construction and operation of Warm Springs Dam (federal sites) and inspection of one nonfederal site (Public Law 84-99).

4. NPDES stormwater discharge permit activities in the Santa Rosa area.

MCRRFCD conducts channel maintenance activities related to the CVDP in the Mendocino County portion of the Russian River. This includes channel maintenance related to federal sites and inspection of Public Law 84-99 (nonfederal) sites. MCRRFCD also conducts activities related to streambank erosion control in the Russian River.

3.6.1 Central Sonoma Watershed Project

In addition to constructed flood control channels (discussed in the following section), the Central Sonoma Watershed Project includes four flood control reservoirs built in the late 1960s to reduce flooding in the Santa Rosa area. These four flood control reservoirs are located on Santa Rosa, Brush, Paulin, and Matanzas creeks. The Santa Rosa Creek Reservoir (Spring Lake) is located offstream. A diversion structure at the inlet allows relatively low flows to bypass the reservoir, routing the flow downstream into Santa Rosa Creek, while a portion of the higher flows are diverted into the reservoir. A diversion structure on Spring Creek also diverts water to Spring Lake. Spring Lake drains back to Santa Rosa Creek through a stand pipe when water levels become too high. Other than the Santa Rosa Creek Reservoir, the other flood control reservoirs are situated onstream and are equipped with facilities (low-flow bypass and principal spillway) that allow minimum streamflows to be released. These reservoirs operate passively and are not equipped with flood control gates.

Facilities are not provided for anadromous fish passage above the instream flood control reservoirs or the diversion on Spring Creek. However, a fish ladder and vortex weir are located on Santa Rosa Creek to assist anadromous fish passage.

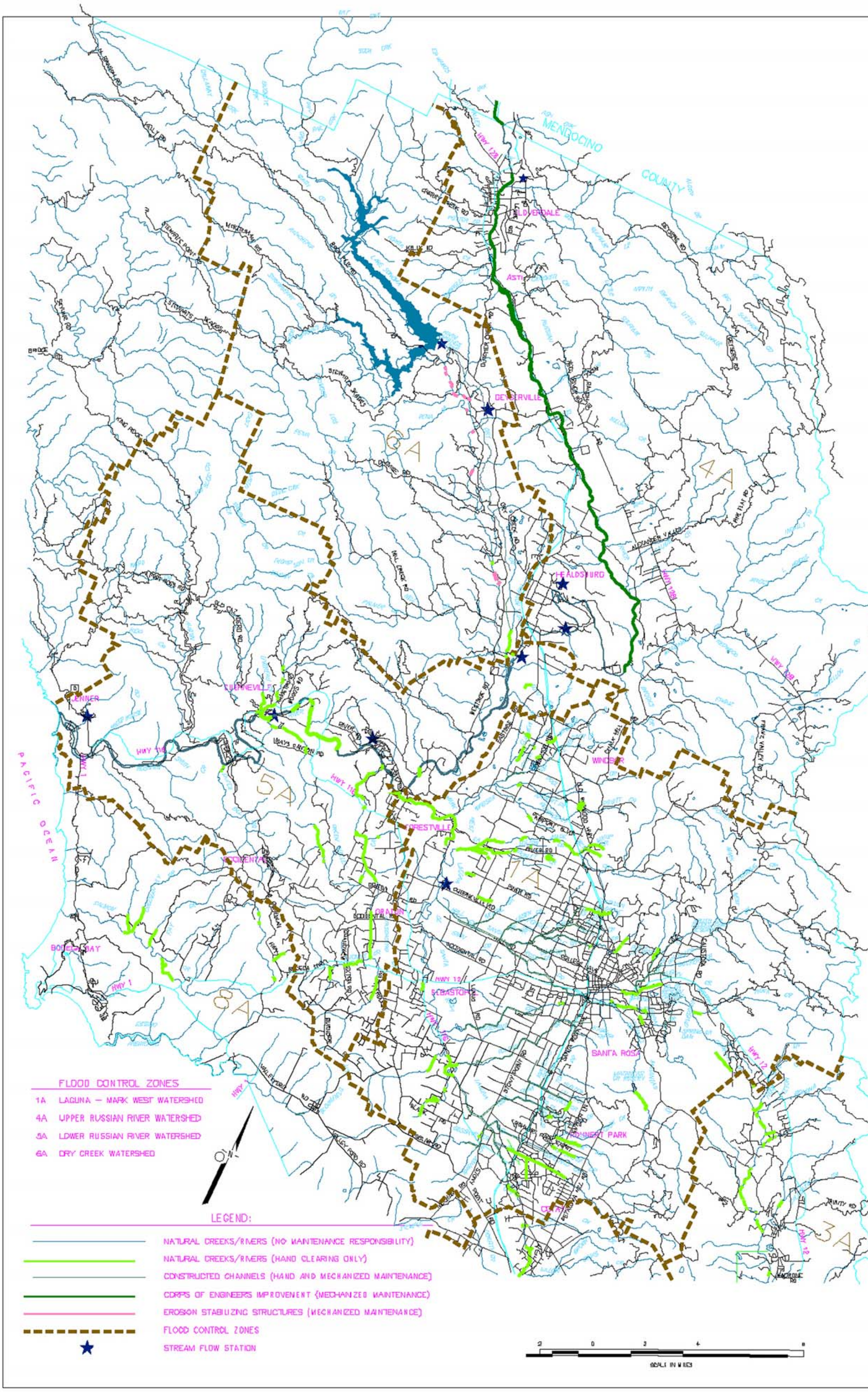


Figure 3-5 Channel Maintenance Areas of the Russian River Watershed

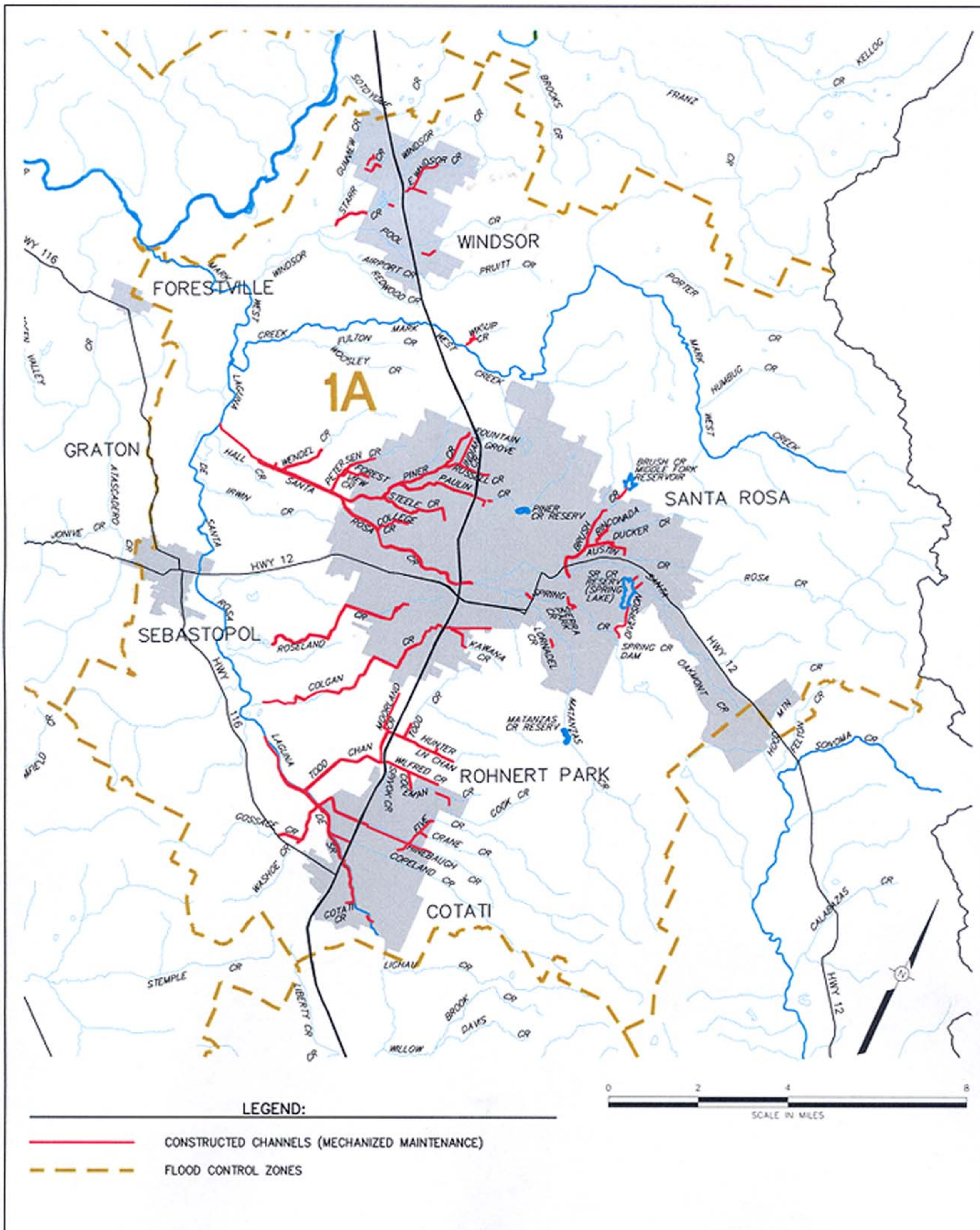


Figure 3-6 Zone 1A Constructed Flood Control Channels

3.6.2 NATURAL WATERWAYS AND CONSTRUCTED FLOOD CONTROL CHANNELS MAINTAINED IN THE RUSSIAN RIVER WATERSHED

SCWA conducts channel maintenance activities on approximately 300 miles of creeks within Sonoma County. Most of these streams are located in the Russian River watershed. The creeks include both natural waterways and constructed flood control channels.

Channel maintenance activities for these channels are discussed in this section. Channel maintenance activities related to the Coyote Valley Dam and Warm Springs Dam projects in the Russian River and Dry Creek are discussed in the following section.

3.6.2.1 Constructed Flood Control Channels

Constructed flood control channels (many of which are part of the Central Sonoma Watershed Project) are widened and straightened waterways that have been significantly altered and improved based on flood control criteria (Table 3-12). The purpose of the

Table 3-12 Constructed Flood Control Channels (Portions Thereof) Maintained by SCWA in the Russian River Watershed

Airport Creek	Forestview Creek	Paulin Creek	Starr Creek
Austin Creek	Gird Creek	Peterson Creek	Steele Creek
Brush Creek	Gossage Creek	Piner Creek	Todd Creek
Coleman Creek	Hinebaugh Creek	Redwood Creek	Washoe Creek
Colgan Creek	Hunter Lane Channel	Rinconada Creek	Wendell Creek
College Creek	Indian Creek	Roseland Creek	Wikiup Creek
Cook Creek Sediment Basin	Kawana Creek	Russell Creek	Wilfred Creek
Copeland Creek	Laguna de Santa Rosa	Santa Rosa Creek	Windsor Creek
Ducker Creek	Lornadell Creek	Sierra Creek	Woods Creek
Faught Creek	Norton Slough	Spivok Creek	
Five Creek	Oakmont Creek	Spring Creek	

improvements is to increase hydraulic capacity. SCWA either owns in fee the rights-of-way for constructed flood control channels, or holds a drainage easement on them. These channels generally include service roads to facilitate maintenance access.

Sediment removal was historically performed on an annual basis in the constructed flood control channels. Sediment removal is now conducted on an as-needed basis. Some of the constructed flood control channels require annual sediment removal, some require sediment removal approximately every 2 to 5 years, and some have never required sediment removal. Recent sediment removal activities on flood control channels have included Copeland, Colgan, Russell, Todd, Indian, Hinebaugh, and Roseland creeks, as well as the Cook Creek sediment basin.

SCWA performs routine vegetation maintenance for flood control purposes on approximately 150 miles of constructed flood control channels in Sonoma County. The access roads for these channels were historically kept clear of vegetation through the use of residual herbicides, which are effective for an extended period of time. Since the early 1990s, access roads have been cleared with aquatic contact herbicides (which are effective only at the time of application [i.e., early spring]) and mowing.

Historically, SCWA was required to limit all vegetation on streambanks to predominately grass, with little or no tree growth. This represents baseline conditions. Since coho salmon were listed under the ESA, vegetation maintenance practices have been more limited.

Historically, the upper third of the channel bank was mowed to remove all grasses, bushes, and small trees. Since 1996, some vegetation has been allowed to develop and existing trees are maintained. Maintenance of the middle third of the channel bank has typically been limited to debris removal and light thinning of willow growth, as necessary.

Vegetation maintenance on the lower third of the channel, including the toe of the channel, was historically conducted annually. Recently, vegetation removal along the lower third of the bank has been less frequently performed and is more selective, leaving some widely-spaced woody riparian growth, but preventing dense vegetation.

The original design of these channels assumed that the 100-year-flood capacity[5] could be maintained by keeping these channels free of sediment and most vegetation, except for grasses. A hydraulic assessment of selected Zone 1A constructed flood control channels (Figure 3-6) was performed in 2000 to quantify flood capacity under baseline vegetation management scenarios. Flood capacity under various vegetation maintenance practices were also modeled (ENTRIX, Inc. 2002a) using USACE HEC-RAS. This assessment evaluated the channel maintenance needed to ensure that the design flow, typically a 100-year recurrence interval discharge (for drainage areas greater than 4 mi^2), can be safely passed. It should be noted that sediment deposition is another factor that can diminish hydraulic capacity, but this was not included as part of the model simulations, so interpretation of the results are based only on the influence of vegetation. Furthermore, not all channels were modeled, and hydraulic capacity of channels can only be definitively determined on a case-by-case basis.[6] However, most channels were originally designed with the expectation that there would be adequate flood capacity if vegetation were maintained primarily as grasses.

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[5] Design capacity for flood control channels is based on a sliding scale determined by the size of the area drained. For areas greater than 4 square miles (sq mi), channels were designed to pass the 100-year event, For areas between 1 sq mi and 4 sq mi, channels were designed to pass the 25-year event, and for areas less than 1 sq mi, channels were designed to pass the 10-year event.

[6] Hydraulic modeling was conducted on portions of streams that represent a range of channel types, including Hinebaugh, Santa Rosa, Colgan, Five, Piner, and Brush creeks.

The following four vegetation maintenance scenarios were evaluated:

> *Original Design.* To maintain the 100-year flood (i.e., the design flow), it is assumed that only low grass exists on the banks, that no shrubs or trees are present, and that the channel bed is vegetation free. This represents the baseline condition upon which the channel designs were originally developed.
>
> *No Maintenance.* This scenario assumes full development of mature vegetation on the bed and banks, and the presence of dense woody vegetation, tall weeds, willows, shrubs, and trees. This scenario also assumes encroachment of vegetation from banks into the channel and dense aquatic vegetation on the bed. This condition would exist on many of the constructed flood control channels if all vegetation maintenance activities were to cease for at least 15 years.
>
> *Post-Maintenance.* The bottom 5 feet of bank above the channel bed has no more than 2 year's worth of growth, allowing only scattered small shrubs and young willows (less than 5 feet tall). The rest of the bank above 5 feet from the channel bed is subject to thinning to prevent dense understory of willows, blackberries, and other shrubs. Existing mature trees are not removed, and banks may become moderately well-vegetated. The channel bed is in near-original design condition; however, some encroachment of vegetation from banks and aquatic vegetation, primarily tules and grasses, establishes initially (up to 2 years of growth).
>
> *Pre-Maintenance.* This scenario describes the channel condition just prior to the post-maintenance activities. It assumes a 5-year cycle between the post-maintenance work periods, and thus 5 years of vegetative growth on the bed and banks. The bottom 5 feet of bank above the channel bed will be expected to have moderately dense shrubs and many willows over 5 feet high. The rest of the bank height above 5 feet will have developed slightly more dense vegetation than in the post-maintenance scenario. The channel bed is also expected to have 5 years of growth that allows tules, grasses, and a few scattered young willows to establish. However, observations indicate that streams with active flow during the summer period will maintain most of the channel bed free from dense vegetative growth (willows are unlikely to establish in standing water.)

This hydraulic assessment suggests that, other than Five Creek and possibly the few high-gradient, high-width depth ratio channels (for example Hinebaugh Creek upstream of Highway 101), most channels need aggressive maintenance activities to keep vegetation from growing into a dense brushy stage to provide 100-year-flood capacity. Table 3-13 provides a brief summary of findings from the hydraulic assessment.

Table 3-13 Summary of Findings, Hydraulic Assessment of Zone 1A Constructed Flood Control Channels under Various Maintenance Scenarios

Maintenance Scenario	Sufficient Capacity	Creek Evaluated
Original Design		
100-year flood	No	Santa Rosa Creek downstream of Willowside Bridge, Hinebaugh Creek Laguna de Santa Rosa confluence to near La Bath Bridge (4,000 feet), and one segment of Colgan Creek.
	Yes	All other channels evaluated in this analysis.
10-year flood	No	Santa Rosa Creek downstream of Willowside Bridge.
No Maintenance		
100-year flood	Yes	Five Creek from Hinebaugh Creek channel to Snyder Lane, Hinebaugh Creek from upstream of Snyder Lane downstream to Hinebaugh Interception channel (3,000 feet), and a few high-gradient, high width depth ratio channels.
	No	All other channels evaluated in this analysis.
Post-Maintenance		
100-year flood	Yes	Almost all segments of Santa Rosa, Piner, and Hinebaugh creeks.
	No	Lowest segment of Hinebaugh Creek, and several short segments of Santa Rosa, Piner, and Hinebaugh creeks.
25-year flood	Yes	Santa Rosa, Piner, and Hinebaugh creeks.
Pre-Maintenance		
100-year flood	Yes	Hinebaugh Creek upstream of Highway 101 Bridge, and Five Creek.
	No	All other channels evaluated, including Santa Rosa Creek and Piner Creek downstream of Highway 101.

The post-maintenance scenario, which describes vegetation management practices in the 1990s, provides 100-year-flood capacity in most of Santa Rosa, Piner, and Hinebaugh creeks, but not always with sufficient freeboard. Therefore, site-specific areas may require vegetation maintenance that maintains original design capacity (baseline). Because 100-year flows are not contained in Santa Rosa Creek under the pre-maintenance scenarios, it will likely be necessary to perform maintenance more frequently than on the 5-year cycle modeled, or to maintain the original design capacity. Santa Rosa Creek downstream of the Willowside Road Bridge was the only channel segment with insufficient original design capacity to accommodate even the 10-year flood event. Only in Five Creek, and a portion of Hinebaugh Creek, will the pre-maintenance scenario provide capacity for the 100-year flow.

Except for a handful of bridges and culverts, most were capable of passing the 100-year discharge under pre- and post-maintenance scenarios. The culvert at Snyder Lane in Hinebaugh Creek appears to be the only location that cannot pass the 100-year flow under the original design and meet SCWA criteria for freeboard. The following bridges do not have the capacity to pass the 100-year discharge under either the pre- or post-maintenance scenarios, or both, and require the original design maintenance scenario.

Santa Rosa Creek	Stony Point Bridge: pre- and post-maintenance Willowside Bridge: pre-maintenance
Piner Creek	Hopper Ave. culvert: pre- and post-maintenance
	Fulton Road Bridge: pre- and post-maintenance
Hinebaugh Creek	Snyder Lane: original, and pre- and post-maintenance Redwood Ave. culvert: pre- and post-maintenance

A recent USACE study for the Santa Rosa Creek watershed that updates and re-evaluates rainfall and runoff conditions indicates that flood flows are of a higher magnitude than has been historically calculated and used to design flood control facilities (USACE 2002a & b). SCWA is currently developing a more detailed study to evaluate the hydrology of the watershed and the hydraulic capacity of the flood control channels by examining and verifying several of the assumptions in USACE analysis. This study is part of the Santa Rosa Creek Ecosystem and Flood Damage Reduction Feasibility Study (USACE 2002b).

3.6.2.2 Natural Waterways

Natural waterways are those that have not been modified for flood control purposes by SCWA or USACE. SCWA holds permissive channel-clearing easements on many natural waterways in the Russian River watershed (Table 3-14).

Sediment removal is not routinely performed on natural waterways. Occasionally, sediment and debris removal is conducted on natural waterways in response to an event such as a large storm. In recent years, this has included Austin and Big Sulphur creeks. These activities have been treated as emergency repairs. Based on past history, such activities occur once every 5 to 10 years.

Table 3-14 Natural Waterways (Portions Thereof) Historically Maintained by SCWA in the Russian River Watershed

Atascadero Creek	Fife Creek	Laguna de Santa Rosa	Roseland Creek
Barlow Creek	Forestville Creek	Libreau Creek	Santa Rosa Creek
Blucher Creek	Foss Creek	Lower Russian River	Sheephouse Creek
Burton Ditch	Fountain Grove Creek	Mark West Creek	Spring Creek
Calder Creek	Fulton Creek	Matanzas Creek	Starr Creek
Coleman Creek	Green Valley Creek	Norton Slough	Steele Creek
Colgan Creek	Hartman Creek	Olivet Creek	Wikiup Creek
Copeland Creek	Hessel Creek	Paulin Creek	Wilfred Creek (N Fork)
Crane Creek	Hood Mountain Creek	Piner Creek	Willow Creek
Dry Creek	Hulburt Creek	Pocket Canyon Creek	Windsor Creek
Dutch Bill Creek	Jonive Creek	Rieman Creek	Woolsey Creek

Regular maintenance on natural waterways was performed historically with the objective of maximizing the hydraulic capacity without enlarging the waterways. In the 1970s to 1980s, SCWA staff used heavy equipment and hand crews with chainsaws to clear vegetation from the bottom of natural waterways. The use of heavy equipment ended in 1987, with clearing continuing to be performed by four-person crews using hand labor. Currently, no maintenance is performed unless SCWA elects to do so to protect adjacent property.

3.6.3 Channel Maintenance Related to Construction and Operation of Coyote Valley Dam and Warm Springs Dam

3.6.3.1 Coyote Valley Dam

SCWA and MCRRFCD were designated as the local agencies responsible for channel maintenance below Coyote Valley Dam following completion of the dam. USACE provided MCRRFCD and SCWA with O&M manuals for Mendocino and Sonoma counties, respectively (USACE 1965a, 1965b), and the *Water Control Manual for Coyote Valley Dam* (USACE 1986a). These manuals include procedures for operating the dam and maintaining the flood control improvements on the Russian River.

The Russian River naturally exhibits substantial meandering, erosion, and aggradation, which has caused problems near the channel maintenance sites since they were constructed. Operation and maintenance of these sites became the responsibility of local agencies after construction. Manuals provided by USACE (USACE 1965a, 1965b) have provided guidelines for inspecting and maintaining the installed improvements on a yearly basis, or as needed before, during, and after flood events.

In addition to channel improvements installed as part of the mitigation project for Coyote Valley Dam, SCWA and MCRRFCD are responsible for inspecting certain channel improvement sites that were constructed between 1956 and 1963. The sites are located at various places in Sonoma and Mendocino counties, extending from RM 98 near Calpella to approximately RM 40 near Maacama Creek in Healdsburg.

3.6.3.2 Warm Springs Dam

Channel improvements at 15 sites along Dry Creek were built by USACE between 1981 and 1989 as part of the Warm Springs Dam and Lake Sonoma Project. The improvements include three rock-type grade-control structures, 5,800 feet of riprap bank protection, and flow-deflection fences. These improvements were intended to provide bank and riverbed stabilization at sites where erosion previously occurred or where studies indicated that future erosion was likely, due to the construction and operation of Warm Springs Dam. Maintenance responsibility for the channel stabilization project lies with SCWA, as established by an agreement between SCWA and USACE in June 1988. USACE provided to SCWA the *Warm Springs Dam and Lake Sonoma Project, Russian River Basin, Dry Creek Channel Improvements, Sonoma County, California Operation and Maintenance Manual* (Warm Springs Dam O&M Manual) (USACE 1991). This manual provides information, instruction, and guidance to the personnel responsible for proper operation, inspection, and maintenance of channel improvements and bank stabilization measures along Dry Creek downstream of Warm Springs Dam. Specific works are identified in the Warm Springs Dam O&M Manual.

Maintenance work associated with these sites can involve incidental sediment, vegetation, debris removal, and bank stabilization to ensure the structural integrity of the improvements. Outside of the work done on the 15 channel improvement sites in Dry Creek, additional vegetation removal for flood control or bank erosion is not performed in Dry Creek by SCWA or USACE.

Inspections are performed on the one non-federal levee (Public Law 84-99) on Dry Creek, and the property owner is informed of the needed repairs.

3.6.3.3 Bank Stabilization on the Russian River and Dry Creek

Bank stabilization activities by SCWA and the MCRRFCD on the Russian River and its tributaries are limited to maintenance of past channel improvement projects, several of which were implemented by USACE on the Russian River, and for which SCWA and the MCRRFCD are the local sponsoring agencies responsible for maintenance.

Examples of bank stabilization structures previously installed and now maintained, as necessary, include anchored steel jacks in single and multiple rows, flexible fence training structures, wire mesh and gravel revetments (i.e., retaining wall), and pervious erosion check dams. Anchored steel jacks, used in bank protection, are utilized to prevent streambanks from undercutting. The jacks are ¼-inch angle iron with 16-foot legs, cabled together and anchored to the streambank on the ends. Previous erosion check dams consist of gravel and wire mesh, and are used to control sheet erosion on streambanks. Many of the channel improvements described above were implemented to prevent erosion and provide bank stabilization. Many have been covered with soil, brush, and trees, and continue to provide the protection they were designed for with little or no maintenance needed.

The channel improvement areas and levees are inspected periodically by SCWA, MCRRFCD, and USACE. USACE then recommends maintenance work that may be needed. If a need for repairs is identified, those repairs are implemented and described in the annual reports to USACE.

In the Russian River, SCWA and MCRRFCD generally keep the project levees free from vegetation, remove instream gravel bars that may be impeding or diverting flow, and inspect and maintain the channel improvement sites. Typical maintenance recommendations for the channel improvement sites have included removing loose anchor jacks from the river, adding bank erosion protection, managing vegetation to reduce blockage of the river channel and increase access for maintenance and inspection of the banks, repairing or replacing loose grout or riprap, and removing driftwood.

SCWA and MCRRFCD are also responsible for inspecting certain levees along the upper Russian River under a program administered by USACE (PL 84-99). Inspections and small repairs to these non-project levees (non-federal sites) have typically been performed by SCWA. If major repairs are needed, the property owner and USACE are notified.

Streambank maintenance performed by MCRRFCD in the Russian River in Mendocino County consists of obstacle removal, streambank repair, and preventive maintenance. Because most bank erosion is caused by the river being directed into the riverbank by obstacles within the banks, most of the maintenance work is directed toward the removal of these in-channel obstacles. MCRRFCD assesses approximately 1/3 of the length of the river channel in Mendocino County each year, and works on sites identified within that area.

In Mendocino County, the summer flow, or low-water, channel is approximately 25 percent of the width of the winter flow, or high-water channel. The summer flow channel typically meanders from one side of the high-water channel to the other. In this configuration, willows have a tendency to take root on the inside bend of the low-flow channel during the summer and collect gravel during the ensuing winter. Bars tend to form as vegetation develops, creating low-velocity zones that encourage sediments to deposit. If left unchecked, this process continues until a willow-reinforced bar has developed to a size that is sufficient to divert the river into the high-water streambank, causing extensive bank erosion and river siltation. MCRRFCD has stated that, if left unchecked, the bars can, and have, developed into 10-foot high, 1,000-foot long, willow-covered deposits that obstruct and divert winter high-flows and increase the risk of bank erosion. This same condition exists in the Alexander Valley of Sonoma County.

MCRRFCD has maintained the river channel by removing willows from bars that develop as obstacles to high-water flows. Willow growth is controlled before a substantial bar can develop within the low-velocity waters created by the willows. If a riverbank failure occurs, the eroded bank material is often used to reestablish the high-water riverbank. Willows removed from bars are pushed against the bank where they take root and provide erosion control as well as riparian enhancement. This maintenance work is normally done at the end of the summer during low-flow conditions. This work has been performed with as little invasion into the stream channel as possible.

Major channel work has been performed by MCRRFCD in the past. Thousands of yards of gravel have been pushed up against the banks in an effort to provide bank stabilization and eliminate channel braiding. Currently, CDFG recommends actual removal of the gravel; however, MCRRFCD has not found removal of the gravel to be feasible.

Historically, extensive vegetation and sediment maintenance activities were conducted in the Russian River. Since coho salmon were listed under the ESA, these activities have been much more limited. Due to ESA considerations, USACE permits have not been issued for some activities. However, the activities described above represent baseline conditions.

3.6.4 Gravel Bar Grading in the Wohler and Mirabel Area

Infiltration capacity at the Wohler and Mirabel diversion facilities is augmented by periodically recontouring gravel bars in the Russian River upstream and downstream of the inflatable dam. Protocols for this activity may differ from those conducted for channel maintenance, so these activities are discussed separately.

SCWA currently conducts grading at four bars in the Mirabel and Wohler areas. Three of the bars, the Bridge Bar, Wohler Bar, and McMurray Bar, are upstream of the inflatable dam. The bar at Mirabel is the Mirabel Bar. The McMurray and Mirabel bars are approximately 1,000 feet long and 200 feet wide. The other two gravel bars are approximately 500 feet long and 100 feet wide.

Gravel bar skimming operations may be performed in the spring of every year on the Wohler, McMurray, and Bridge gravel bars when streamflows drop below approximately 800 cfs, and before the dam is inflated. This work is performed at various times, depending on the flow in the river and demands on the water system, but the work is generally performed between March and July. The Mirabel gravel bar is skimmed between July and October, depending on flow conditions. Gravel at these locations is generally pushed up on the bank using bulldozers and scrapers, and is sometimes removed and stockpiled outside the channel.

3.6.5 Factors Affecting Species Environment

Channel maintenance activities in the Russian River watershed are conducted to reduce the risk of flooding of local property and bank erosion. Effects of these activities under baseline practices were evaluated in *Interim Report 5: Channel Maintenance* (ENTRIX, Inc. 2001b).

The most urbanized portions of the watershed are in Santa Rosa and in the Cotati-Rohnert Park areas. These areas contain most of the constructed flood control channels. Conventional sediment maintenance activities in constructed flood control channels reduce fish passage to spawning and rearing habitat and restrict downstream migration. However, natural waterways and constructed channels in the Rohnert Park area are generally low-gradient and run through a valley plain to the Laguna de Santa Rosa. Poor summer water quality from urbanized areas and low summer flows limit rearing habitat in these channels. Since rearing habitat is limited, there is a moderate effect from sediment maintenance activities on salmonid populations.

Santa Rosa Creek drains to the Laguna de Santa Rosa, which in turn drains to Mark West Creek. Channel maintenance activities on constructed flood control channels and natural waterways in this part of the Mark West Creek watershed, including the Santa Rosa Creek watershed, have the potential to affect coho salmon and steelhead because this part of the watershed contains good rearing and spawning habitat for these species. Much attention has been given in recent years to restoration opportunities in this area. SCWA restoration actions within this watershed are outlined in Section 3.7.

SCWA channel maintenance activities under USACE obligations in Dry Creek are limited to maintenance of the 15 channel improvement sites. Potential spawning and rearing habitat for steelhead and Chinook salmon occurs in Dry Creek. Dry Creek does not currently contain much suitable coho salmon rearing habitat, but coho salmon may use Dry Creek for some or all of their life-history stages. Although removal of riparian vegetation at a few site-specific locales may reduce cover and shading, the effects to listed fish species are limited. Vegetative growth along riprap sites is retained as long as it does not threaten slope stability or encourage erosion.

Bank stabilization activities in the Russian River potentially may have affected populations of listed fish species, because large amounts of river and stream channel habitat have been altered. The most valuable spawning and rearing habitat occurs upstream of Asti in Mendocino County. Gravel bar grading and vegetation removal potentially affects listed fish species by reducing pool habitat formation, causing loss of high-flow refugia, and reducing shade canopy and cover. Loss of riparian vegetation associated with bank stabilization activities in the mainstem Russian River may have a moderate effect when shade canopy and cover are reduced.

Gravel bar grading occurs in the Mirabel and Wohler area to increase infiltration to the aquifer. The 2-mile reach above the inflatable dam at Mirabel has relatively few structural features that would create low areas outside the main channel. Given the characteristics of the river, gravel bar grading is not likely to significantly change the geomorphology of the channel. Effects from gravel bar grading operations are restricted to immediate, short-term effects, including a low risk of entrapment of migrating juveniles and short-term turbidity spikes as the Mirabel Bar is isolated or reconnected to the river. Therefore, the overall risk for injury and habitat degradation is low. The gravel bar grading activity in the upstream sites normally occurs after the coho salmon and Chinook salmon outmigration periods, although in some years it may occur during the later portion of the outmigration. There is a greater risk to steelhead juveniles, which are more likely to be present during gravel bar grading work. However, implementation of BMPs evaluated during the Mirabel Rubber Dam/Wohler Pool monitoring study (Chase et al. 2000) reduces the risk. Gravel bar grading at Mirabel normally occurs in late summer, and does not normally coincide with outmigration of salmonids. Fish rescues are conducted, and no salmonids were found in fish rescues in 1999.

3.7 RESTORATION AND CONSERVATION ACTIONS

SCWA has implemented many projects over the past several years that are designed to contribute to the conservation of natural resources in the Russian River watershed, particularly species listed under the ESA. This includes projects that SCWA has funded or implemented with staff time and materials, or with a combination of SCWA funding and other resources. These efforts include the general categories of watershed management, riparian and aquatic habitat protection, restoration, and enhancement. Actions that have been implemented before the MOU was signed (December 31, 1997) are part of the baseline.

3.7.1 WATERSHED MANAGEMENT

SCWA historically has been involved with watershed management activities in the Russian River watershed. Recently, SCWA has taken a more proactive role with regard to restoration and enhancement projects, and stewardship of the watershed. Several specific projects related to SCWA's contributions to watershed management in the Russian River basin are described below.

In March 1995 and October 1996, SCWA conducted two public workshops before its Board of Directors on watershed management activities and, specifically, SCWA's role in those activities. In August 1996, SCWA published the report, *The Russian River: An Assessment of Its Condition and Governmental Oversight*. In January 1997, SCWA began publishing the *Russian River Bulletin*, an interagency publication circulated among government agencies and other interested parties to describe new programs, legislation affecting or involving the Russian River, and the status of ongoing projects. In addition, SCWA has created a library, available to the public and other agencies, containing reports, documents, and other information pertinent to the Russian River watershed.

3.7.1.1 Russian River Basin Plan Review

SCWA is providing funding for the NCRWQCB to conduct a review of its Russian River Basin Plan (Basin Plan) to determine whether the requirements of the Basin Plan are sufficient to protect fish species in the Russian River. This information will assist ongoing efforts in the Russian River watershed for watershed management and protection of listed fish species. It will not only provide more information on the requirements of these species, but also an assessment of the adequacy of existing regulatory requirements in protecting these species. The review may lead to changes in regulatory standards.

3.7.2 RIPARIAN AND AQUATIC HABITAT PROTECTION, RESTORATION, AND ENHANCEMENT

3.7.2.1 Fisheries Enhancement Program Project Descriptions

SCWA began implementation of the FEP in 1996. SCWA's Board of Directors has directed SCWA to develop the FEP for the tributaries of the Russian River watershed. Since 1996, SCWA has issued an annual Request for Proposals (RFP) for fisheries enhancement work within the Russian River watershed. Projects funded to date have included both on-the-ground restoration and research efforts.

Since 1996, SCWA has granted funds to various entities each year to provide habitat restoration and research on listed fish species in the Russian River watershed. For example, SCWA has provided funding to nonprofit groups, private landowners, and public agencies through the FEP program. In addition, SCWA has contributed staff time and materials to many of these projects.

In addition to the FEP projects, SCWA provided staff and materials for a training session on instream habitat enhancement structure construction in 1996. The training was offered to individuals in the community interested in working on habitat improvement projects, creating a pool of trained individuals to work with SCWA and CDFG on future habitat improvement projects.

1. Stream Habitat Surveys

   Stream habitat surveys have been conducted in cooperation with CDFG each year of the FEP since 1996, and are intended to assess the habitat conditions of streams that are potentially viable for salmonid production. The surveys are used to identify streams that are in need of enhancement or restoration. Surveys are conducted according to the CDFG Habitat Restoration Manual. All data gathered are entered into CDFG's computer program to prioritize stream restoration projects. SCWA has allocated staff and materials for this project.

2. Temperature Data Collection

   Water temperature monitoring has been conducted each year of the FEP since 1996 in collaboration with CDFG and Mendocino County Water Agency. These data will be used to identify streams that provide suitable summer thermal conditions for salmonid juvenile rearing. Data loggers (i.e., equipment to monitor and record water quality measurements at specific intervals) are removed annually from each stream during the fall and deployed again the following spring. Temperature data have been collected in the following watersheds: Mark West, Maacama, Austin, East Austin, Santa Rosa, Dutch Bill, Hulbert, Dry, Brush, Matanzas, and Big Sulphur creeks, as well as in the mainstem. SCWA has allocated staff and equipment for this project. The Mendocino County Water Agency compiles all temperature data into a single database.

3. Water Quality Sampling

   This project includes collecting and identifying invertebrates from several streams in the Russian River watershed and analyzing the samples as indicators of water quality. Reference streams identified by CDFG have been sampled for a minimum of 2 years to establish a baseline reference condition. Other streams sampled are compared to those reference streams to determine relative water quality status. This project has been implemented each year since 1996. SCWA contributes staff and materials for the project. Additionally, SCWA provided funding for analysis of samples.

4. Instream Habitat Improvements

   SCWA has funded and/or implemented projects every year since 1996 to improve habitat in stream channels. Streams identified as candidates for instream habitat improvements include Green Valley, Freezeout, Dutch Bill, and Austin creeks. Instream habitat structures placed in these streams consist of large woody debris, such as rootwads, that provide salmonids protective cover from predators and that promote development of pools. Fencing has also been installed. SCWA provided matching funds and staff support for these projects.

5. Riparian Restoration

   SCWA has funded and/or implemented projects on Little Briggs, Green Valley, Austin, Copeland, and Freezeout creeks to exclude livestock from the riparian zone adjacent to the stream, and to replant degraded areas with native vegetation. These projects were intended to allow riparian vegetation to re-establish, stabilize streambanks, and decrease animal waste entering the stream. On Green Valley Creek, SCWA has also worked with Trout Unlimited and the landowners to provide temporary water supplies to restored riparian areas to increase the survival of newly planted trees. On Porter and Matanzas creeks, SCWA has implemented projects to enhance riparian habitat and stabilize streambanks. These projects consisted of placing bioengineered erosion structures such as willow mattresses and baffles, planting native riparian trees in upslope areas, and educating landowners on ways to prevent erosion and the value of riparian vegetation along streambanks on their property. SCWA has provided funding, staff, and materials for these projects.

6. Green Valley Creek Restoration

   Two restoration projects were implemented to improve habitat conditions for coho salmon and steelhead in Green Valley Creek, both designed to reduce streambank erosion. Green Valley Creek is one of the few tributaries in the Russian River watershed that still supports a self-sustaining, although diminished, population of threatened coho salmon. The Green Valley Creek watershed is held entirely in private ownership, and efforts aimed at improving habitat conditions for species recovery require the voluntary participation of landowners. Trout Unlimited and CDFG constructed two streambank stabilization projects in 1996 that did not perform as intended. One failed in 1998 and the other was in danger of failing. The sites delivered substantial amounts of fine sediment to the stream. Dragonfly Stream Enhancement, in conjunction with two private landowners, repaired both projects and arrested accelerated erosion at both sites. The site improvements include sloping and armoring of an eroding bank, planting of native vegetation to stabilize the sites, and removal of non-native vegetation. SCWA provided funding for the project.

Table 3-15 summarizes actions that are part of the baseline, and indicates the listed fish species the action is likely to affect, where known. Steelhead are the most abundant species in many of these areas, but as coho salmon or Chinook salmon populations are recovered, utilization of these streams by these species is likely to increase. All projects listed are likely to improve habitat for spawning, rearing, and migration of listed salmonids.

Table 3-15 Summary of Restoration and Conservation Actions

Creek	Type of Project	Size of Project	Species Affected[1]
Baseline Projects[2]			
Instream Habitat Improvements			
Green Valley	Contiguous structures and fencing	~ 1 mile	Co, St
Freezeout	3 non-contiguous structures		Co, St
Riparian Restoration			
Green Valley (streambank stabilization)	Erosion control	2 small projects	Co, St
Green Valley (livestock exclusion)	Fencing	> 1 mile	Co, St
Freezeout	Fencing	3,000 feet	St
Little Briggs	Fencing	> 1 mile	St
Porter	Willow walls & mattresses	~300 feet	St

[1] Co = Coho salmon, St = Steelhead, Ch = Chinook salmon

[2] Actions completed prior to December 31, 1997.

The size of the project is the actual length of stream affected.

3.8 FISH PRODUCTION FACILITIES AND OPERATIONS

The DCFH and CVFF are fish production facilities located in the Russian River basin. The DCFH (also referred to as the Warm Springs Fish Hatchery) is located on Dry Creek at the base of Warm Springs Dam. The CVFF is a satellite facility for the steelhead program at DCFH and is located on the East Fork Russian River at the base of Coyote Valley Dam. Both fish production facilities are owned by USACE and operated by CDFG under a cooperative agreement with USACE. Like all anadromous fish hatcheries in California, the Russian River facilities were developed to mitigate for the loss of spawning and rearing habitat for anadromous salmonids resulting from the construction of dams (CDFG and NMFS 2001).

Fish production goals for the DCFH were established in 1974 to compensate for the estimated loss of coho salmon and steelhead production in Dry Creek upstream of Warm Springs Dam. Additional fish production was included in the hatchery program goals to enhance harvest opportunities for coho and Chinook salmon in the Russian River (USFWS 1978). Fish production goals for CVFF were established in 1984 to compensate for the estimated loss of steelhead production in the East Fork Russian River upstream of Coyote Valley Dam (USACE 1986a). The DCFH and CVFF facilities went into service in 1980 and 1992, respectively.

This section outlines the fish production facilities and their operations as mitigation and enhancement hatcheries under the baseline condition. A detailed description of the baseline program is presented in *Interim Report 2: Fish Operations Facility* (FishPro and ENTRIX, Inc. 2000). Changes in fish facility operations that have occurred since

December 31, 1997 (the defined end of the environmental baseline period) are described as part of the proposed project in Section 4.

3.8.1 Background of Fish Facility Development

To compensate for loss of spawning and rearing habitat upstream of Warm Springs Dam and Coyote Valley Dam, various laws were enacted that ultimately led to the development of DCFH and CVFF. Construction of DCFH was authorized by the Flood Control Act of 1962. DCFH went into service on October 1, 1980.

Section 203 of the Flood Control Act of 1962, later modified by Section 95 of Public Law 93-251, the Water Resources Development Act of 1974, requires a program to compensate for fish losses on the Russian River attributed to the operation of Coyote Valley Dam. In January 1983, the South Pacific Division USACE directed the Sacramento District USACE to assume responsibility for the Coyote Valley Dam Fish Mitigation Project, and to determine what work would be required to comply with Public Law 93-251. The determination resulted in the development of CVFF, along with an expansion of DCFH. Both CVFF and the DCFH expansion became operational in 1992. In October 1996, the South Pacific Division USACE transferred control of Lake Sonoma and Lake Mendocino, including both fish facilities, to the San Francisco District USACE.

Before the fish facilities became operational, no quantitative estimates were conducted to determine the actual carrying-capacity of affected areas. Instead, mitigation goals were developed from run-size estimates within the sub-basins, with additional estimates based on the proportions of coho salmon and steelhead spawning habitat upstream of the dam locations. However, insufficient data existed to support these estimates. For coho salmon and steelhead, population estimates vary widely among studies because they are based on anecdotal information or on assumptions of habitat quality.

CDFG estimated that, before the construction of Warm Springs Dam, the Dry Creek sub-basin supported a run of approximately 8,000 steelhead and 300 coho salmon (CDFG 1970). Approximately 75 percent of the steelhead (6,000) and 33 percent of the coho salmon (100) were believed by CDFG to spawn in sections of Dry Creek and its tributaries that are now upstream of the dam (CDFG 1970). Salmon and steelhead continue to use Dry Creek downstream of the dam for spawning and rearing.

Various estimates of the annual adult steelhead run size in the East Fork Russian River before construction of Coyote Valley Dam ranged from 36 to 7,684 fish (Prolysts, Inc. and Beak Consultants, Inc. 1984). USACE concluded that it would be necessary to produce 4,000 adult steelhead each year to provide adequate mitigation for losses resulting from construction and operation of Coyote Valley Dam (USACE 1986b).

3.8.2 Fish Facility Program Goals

DCFH and CVFF program goals were established to develop and maintain an escapement of 1,100 adult coho salmon, 6,000 adult steelhead, and 1,750 adult Chinook salmon in the Dry Creek drainage, and 4,000 adult steelhead in the upper Russian River drainage. To achieve these escapement goals, production goals were also established for egg harvest and fish-release numbers at DCFH. Similarly, goals for egg-harvest numbers and pounds of yearling releases were established for CVFF. Based on a desired CVFF release size of five fish per pound, the 40,000 pounds of steelhead can be equated to 200,000 steelhead individuals. Production and adult escapement goals for DCFH and CVFF as they existed during the environmental baseline period are summarized in Table 3-16.

Table 3-16 Baseline Hatchery Program Goals for DCFH and CVFF

Location/Species	Mitigation/ Enhancement	Egg Harvest	Juvenile Releases	Adult Escapement
Don Clausen Fish Hatchery				
Steelhead	Mitigation	600,000	300,000 yearling	6,000
Coho Salmon	Mitigation	20,000	10,000 yearling	100
Coho Salmon	Enhancement	200,000	100,000 yearling	1,000
Chinook Salmon	Enhancement	1,400,000	1,000,000 smolts	1,750
Coyote Valley Fish Facility				
Steelhead	Mitigation	320,000	200,000 yearling	4,000

When the baseline hatchery program goals were developed, CDFG established the following definitions and management guidelines:

Coho Salmon:

Yearling release size: 10 fish per pound or larger

Fecundity: 2,000 eggs per female

Survival from unfertilized egg to stocked yearling: 50 percent

Survival from stocked yearling to adult return at hatchery: 1 percent

Steelhead:

Yearling release size: 4 to 5 fish per pound or larger

Fecundity: 5,000 eggs per female

Survival from unfertilized egg to stocked yearling: 50 percent

Survival from stocked yearling to adult return at hatchery: 2 percent

Chinook Salmon:

Smolt: 50 fish per pound or larger (typical for April-May releases)

Yearling release size: 10 fish per pound or larger (typical for November releases)

Fecundity: 4,000 eggs per female

Survival from unfertilized egg to stocked smolt: 75 percent

Survival from stocked smolt to adult return at hatchery: 0.175 percent

The baseline program goals for DCFH and CVFF include an assumed survival rate from release to adult return at the hatchery. Actual survival following release is affected by many factors beyond the control of hatchery operations. While hatchery practices may influence marine survival of salmon, marine survival is also related to ocean-wide factors in the marine environment in the North Pacific, such as climate changes (Beamish and Bouillon 1992). In addition, commercial and sport harvest can have a significant effect on hatchery returns. The stated management goals for survival from yearling release to hatchery return are 2 percent for steelhead and 1 percent for coho salmon. CDFG has noted that these values are higher than the current survival rates for some west coast hatchery stocks of steelhead and coho salmon (B. Coey, CDFG, pers. comm. March 29, 2000a). For example, the 10-year average survival of hatchery winter steelhead released in the East Fork Hood River in Oregon is 0.26 percent, based on the results of the Oregon Department of Fish and Wildlife (ODFW) coded wire tag program (Lewis et al. 2002). If actual conditions experienced by the Russian River stocks are not able to support the assumed survival rate, it is unlikely that the desired adult escapement will ever be achieved if release goals are followed.

No estimates of post-dam carrying-capacity have ever been developed to confirm that the remaining spawning and rearing habitat is capable of supporting the mitigation and enhancement production goals. Also, there are no programs specified in the goals to assess the potential for competition among naturally-spawned and hatchery-spawned components of the same species, or between any of the three salmonid species or other fauna present in the Russian River during the same time periods.

3.8.3 Fish Facility Operations

The following three subsections summarize fish facility operations in the Russian River basin for coho salmon, steelhead, and Chinook salmon. These summaries focus on activities conducted under the DCFH and CVFF mitigation and enhancement programs, but also provide an overview of fish stocking activities conducted prior to implementation of these hatchery programs.

3.8.3.1 Coho Salmon

Historical Stocking Activities

Between 1937 and 1998, approximately 2.3 million hatchery coho were planted in the Russian River basin (Table 3-17). Most of these outplants (approximately 70 percent) occurred between 1981 and 1998 with implementation of the DCFH coho mitigation and enhancement program. This program was discontinued in 1999 due to the lack of sufficient numbers of Russian River coho broodstock.

Steiner Environmental Consulting's review of hatchery records (1996) revealed that at least five out-of-basin coho stocks were introduced to the Russian River as a result of outplanting, most of them from North Coast region hatcheries. These out-of-basin broodstock sources (with the last known year of planting noted in parentheses) included the Alsea River, Oregon (1972), Eel River (1990), Klamath River (1988), Noyo River (1998), and Soos Creek, Washington (1978). The management plan developed for implementation of the DCFH and CVFF programs stated that coho eggs from the Noyo and Eel rivers were acceptable for use in meeting the mitigation and enhancement goals for the DCFH coho program. Russian River coho served as the broodstock for 32 percent of all outplants between 1937 and 1998 (Table 3-17).

Table 3-17 Broodstock Source, Stocking Year, and Number of Coho Salmon Outplanted in the Russian River, 1937 to 1998

Broodstock Source	Years Outplanted	Total Outplants[1]
Russian River	1983, 85-98	752,372
Alsea River, Oregon	1972	58,794
Eel River	1987, 90	25,112
Klamath River	1975, 81-83, 86-88	451,370
Noyo River	1970, 72-74, 82-84, 86-91, 93, 97-98	687,820
Soos Creek, Washington	1978	8,420
Unknown		403,340
Total		**2,387,228**
% Russian River Origin[2]		**32%**

[1] Data compiled from Steiner Environmental Consulting (1982-2003) and DCFH (1996, 1997, and 1998). Some historical records are incomplete. This compilation is intended to convey general magnitude of hatchery planting rather than exact numbers.

[2] As planting records are incomplete, this is only an estimate based on numbers presented in this table. Out-of-basin sources were planted extensively in the past, but this practice was diminished and then discontinued in more recent years.

Distinct periods of coho stocking activities have been described by Steiner Environmental Consulting (1996). The first hatchery coho plant occurred in 1937 with the release of 171,500 fish. No more hatchery coho were planted until 1963. From 1940 to 1980, the Russian River received more than 1.8 million outplants of coho “rescued” from summer-intermittent streams, 44 percent of which came from basins outside the Russian River. (These outplants of rescued fish are not included in the data in Table 3-17.) A third period of activity occurred from 1963 to 1998, when approximately 2 million hatchery coho were planted. During this period, the DCFH program worked to develop a basin-adapted strain of coho to use as the program’s broodstock. This is evidenced by the fact that, between 1963 and 1980, all of the outplants were from out-of-basin stocks; between 1980 and 1989, 15 percent of broodstock came from returning Russian River adults captured at the DCFH facility; and between 1990 and 1995, 85 percent of broodstock were returning Russian River adults (Steiner Environmental Consulting 1996).

There is no known information regarding the survival of fish from coho outplants prior to the DCFH program. Given the magnitude and duration of historical coho stock transfers, it is likely that naturally-spawning coho salmon within the Russian River represent a genetic conglomerate of many stocks. Similarly, coho broodstock for the DCFH program are likely to be descendants of many stocks. While the history of stock transfers in the Russian River suggests that genetic integrity has been compromised, the considerable efforts made after 1980 to collect broodstock from Russian River returns should allow selection and genetic drift to give rise to Russian River-specific stocks.

Broodstock Selection and Mating

Russian River coho broodstock for the DCFH program were collected from fish entering the DCFH ladder and trap. Adult collection and spawning protocols at DCFH require systematic collection across the entire adult return period. Coho program guidelines were aimed to collect and spawn a minimum of 110 females, and generally 1.5 to 2 times those numbers for males. In practice, it is common that more individuals are spawned than are necessary to achieve egg-take goals, both to increase genetic diversity and to protect against catastrophic loss during incubation and early rearing. If there were insufficient Russian River coho salmon to achieve the program egg-take goals, it was acceptable to transfer coho eggs from the Noyo River and/or Eel River to meet the goals.

Between 1993 and 1998, the number of female Russian River coho used as broodstock varied (Table 3-18). The number of males and jacks used as broodstock during this period was not recorded in hatchery records, but has been estimated based on the general spawning protocols in effect at the time. During this period, any naturally-spawned coho that voluntarily entered the traps were retained as broodstock whenever possible. The specific number of naturally-spawned adults used as broodstock is not known, but it has been stated that returning hatchery-reared individuals were the primary source of broodstock (R. Gunter, CDFG, pers. comm. 1999). The DCFH mitigation and enhancement program was terminated in 1999.

Table 3-18 Coho Broodstock Spawning Levels at DCFH from 1993 to 2003

Year[1]	Females (actual)[2]	Males (approx.)[3]
1993-1994	57	114
1994-1995	349	698
1995-1996	32	64
1996-1997	147	294
1997-1998	0	0
1998-1999[4]	0	0
1999-2000[4, 5]	NA	NA
2000-2001[4, 5]	NA	NA
2001-2002[4, 5]	NA	NA
2002-2003[4, 5]	NA	NA

1 Operating year for CDFG extends from July 1 of first year to July 30 of second year.
2 Data regarding females spawned compiled from DCFH annual reports.
3 Total number of males estimated by assuming spawning ratio of 2 males:1 female (CDFG 2002).
4 Activities after 1997 to 1998 are not part of the baseline.
5 The coho mitigation and enhancement program was terminated in 1999.

Rearing and Release

Incubation and fry-rearing functions for the DCFH coho program were conducted inside the DCFH hatchery building. Approximately 6 weeks after hatching, it was typical to transfer the fry into outdoor concrete raceways. Annually, beginning in November, grading was conducted on all coho; those larger than 10 per pound were released to Dry Creek. The DCFH/CVFF management plan stipulated that, in April, any remaining fish that had not yet reached target size were to be released to Dry Creek as well.

Annual release data for the DCFH coho program is presented in Table 3-19, noting the total release number, pounds, and average size at release. The data reflect all releases that occurred between facility start-up through June 2003, even though the environmental baseline ends with the 1997 to 1998 year. Coho salmon releases surpassed the production goal of 110,000 from 1987 to 1992, but poor returns in recent years did not allow adequate egg harvest to meet production goals. Comparison of relevant data on adult returns and egg harvest indicates that coho salmon release numbers are directly related to availability of broodstock, and low release numbers should not be construed as a reflection of hatchery operations. Survival from unfertilized egg to stocked yearling routinely surpassed the management goal of 50 percent.

Release protocols for the coho salmon program called for the fish to be sorted by size; larger individuals were released, while smaller individuals were retained until reaching a larger size. Larger individuals are assumed to emigrate more quickly than smaller individuals, thereby decreasing the risk of freshwater predation and competition. Furthermore, releases were not made in the smaller tributaries where primary spawning and rearing occurs, with the exception of Dry Creek. DCFH releases use a transport truck to haul the fish from the hatchery to their final release location in Dry Creek.

Due to release locations, all coho salmon were acclimated to the Russian River system, suggesting that straying to out-of-basin rivers was unlikely to be a great concern. The DCFH coho rearing program is accomplished using Lake Sonoma water, and releases occur approximately 3 miles downstream from the hatchery in Dry Creek, which emanates from Lake Sonoma. Coho salmon would be expected to return to capture facilities in Dry Creek, rather than to non-natal tributaries.

Table 3-19 Don Clausen Fish Hatchery Coho Salmon Release History

Year[1]	Fingerling			Yearling		
	Number	Pounds	Avg FPP[2]	Number	Pounds	Avg FPP[2]
1981-1982	66,400	1,050	63	30,820	4,600	7
1982-1983	82,987	1,190	70	32,305	3,310	10
1983-1984	3,800	126	30	30,310	4,330	7
1984-1985	67,750	1,010	67	0	0	0
1985-1986	42,525	525	81	86,425	7,325	12
1986-1987	40,809	704	58	123,570	16,250	8
1987-1988	82,211	1,350	61	104,324	17,875	6
1988-1989	0	0	0	100,680	13,083	8

Table 3-19 Don Clausen Fish Hatchery Coho Salmon Release History (Continued)

Year[1]	Fingerling			Yearling		
	Number	Pounds	Avg FPP[2]	Number	Pounds	Avg FPP[2]
1989-1990	0	0	0	128,755	14,200	9
1990-1991	0	0	0	110,690	12,625	9
1991-1992	0	0	0	137,400	15,075	9
1992-1993	0	0	0	85,859	10,605	8
1993-1994	0	0	0	55,528	9,700	6
1994-1995	0	0	0	27,186	2,699	10
1995-1996	0	0	0	96,180	27,570	3
1996-1997	0	0	0	23,380	8,500	3
1997-1998	0	0	0	49,245	8,045	6
1998-1999[3]	0	0	0	0	0	0
1999-2000[3, 4]	0	0	0	0	0	0
2000-2001[3, 4]	0	0	0	0	0	0
2001-2002[3, 4]	0	0	0	0	0	0
2002-2003[3, 4]	0	0	0	0	0	0
Avg - all years	17,567	271	20	55,621	8,048	6
Avg - releases	55,212	851	61	76,479	11,066	8

1 The CDFG operating calendar extends from July 1 of the first year through June 30 of the second year.
2 Avg FPP = average size (fish per pound) at release.
3 Releases made after the 1997 to 1998 year are not part of the baseline.
4 The coho mitigation and enhancement program was terminated in 1999.

Adult Returns

Adult returns to DCFH are presented in Table 3-20. The coho salmon mitigation goal of 100 adult fish has been met 11 out of 19 years, but the enhancement goal calling for an additional 1,000 adult returns has never been achieved. It is suggested that the survival estimate of 1 percent stated in the DCFH and CVFF management plan established optimistic and unrealistic expectations for adult escapement goals.

Table 3-20 History of Coho Salmon Trapped at Don Clausen Fish Hatchery

Year[1]	Male	Female	Grilse	Total
1980-1981	0	0	0	0
1981-1982	2	2	0	4
1982-1983	515	277	194	986
1983-1984	0	1	8	9
1984-1985	32	44	0	76
1985-1986	0	0	0	0
1986-1987	139	5	328	472
1987-1988	164	155	257	576
1988-1989	219	139	176	534
1989-1990	35	35	70	140
1990-1991	100	87	90	277
1991-1992	53	20	89	162
1992-1993	250	113	215	578

Table 3-20 History of Coho Salmon Trapped at Don Clausen Fish Hatchery (Continued)

Year[1]	Male	Female	Grilse	Total
1993-1994	110	62	277	449
1994-1995	310	392	63	765
1995-1996	13	13	36	62
1996-1997	68	68	12	148
1997-1998	1	3	0	4
1998-1999[2]	2	1	5	8
1999-2000[2, 3]	1	0	0	1
2000-2001[2, 3]	0	0	0	0
2001-2002[2, 3]	0	0	0	0
2002-2003[2, 3]	0	0	0	0
Average	88	62	79	228

1 The CDFG operating calendar extends from July 1 of the first year through June 30 of the second year.
2 Activities after 1997-1998 are not part of the baseline.
3 The coho mitigation and enhancement program was terminated in 1999.

Harvest Management

Harvest of coho salmon is prohibited within the Russian River basin. However, there is a fishery within the basin for hatchery-reared steelhead. While this strategy minimizes direct fishing mortality of coho salmon, indirect effects such as hooking mortality and harassment may still occur. There are no current estimates for incidental harvest levels of coho salmon within the Russian River.

Rearing for Out-of-Basin Programs

Until 1999, DCFH received eggs from a coho salmon stock in the Noyo River. Adult fish used as the source of these eggs were tested for viral pathogens (W. Cox, pers. comm., 1999). Upon arrival at the DCFH, the Noyo River eggs were disinfected with iodophore solution to remove surface pathogens that may have been present. Egg lots were incubated separately until completion of viral certification, after which time the egg lots could be combined. After reaching the eyed-egg lifestage, the eggs were transferred to the Mad River Hatchery for hatching, rearing, and release (R. Gunter, pers. comm., 1999). Occasionally, some of the eggs from this source were kept at DCFH and reared for planting into the Russian River for enhancement purposes; however, both this practice and the entire Noyo River incubation program were discontinued in 1999 (R. Gunter, pers. comm., 2000a, 2000b).

3.8.3.2 Steelhead

Historical Stocking Activities

Between 1870 and 1998, more than 33 million hatchery steelhead were planted in the Russian River basin. Before the 1980s, when the ecological distinctness of local stocks gained acceptance, it was common to stock rivers with the progeny of adult fish captured from basins where hatcheries were located. A detailed review of hatchery records conducted by Steiner Environmental Consulting (1996) revealed that, before 1980, at least seven out-of-basin steelhead stocks were introduced to the Russian River, most of them from hatcheries in the North Coast region. These out-of-basin broodstock sources (with the last known year of planting noted in parentheses) included the Eel River (1972), Prairie Creek (1927), Mad River (1981), San Lorenzo Creek (1973), Scott Creek (1911), and Washougal River (Washington) (1981). Russian River steelhead served as the broodstock for 54 percent of all outplants between 1870 and 1998 (Table 3-21).

Table 3-21 Broodstock Source, Stocking Year, and Number of Hatchery Steelhead Outplanted in the Russian River, 1870 to 1998

Broodstock Source	Years Outplanted	Total Outplants[1]
Russian River	1959, 81-98	18,167,885
Eel River	1914-19, 21-23, 58-59, 72	4,900,843
Mad River	1975-76, 78-79, 81	324,101
Prairie Creek	1927	249,000
San Lorenzo Creek	1973	83,350
Scott Creek	1911	433,458
Washougal	1980-81	270,360
Unknown		8,934,122
Total Outplants		**33,363,119**
% Russian River Origin[2]		**54%**

1 Data compiled from Steiner Environmental Consulting (1996) and DCFH (1996, 1997, and 1998). Some historical records are incomplete. This compilation is intended to convey general magnitude of hatchery planting rather than exact numbers.

2 As planting records are incomplete, this is only an estimate based on numbers presented in this table, using the conservative assumption that all unknown broodstock sources come from outside the Russian River basin. It was common in the past for hatcheries to plant fish in many basins. This practice has diminished since the 1980s and was discontinued in the Russian River in 1999.

Three distinct periods of steelhead stocking have occurred since 1870 (Steiner Environmental Consulting 1996). The first period, lasting until 1939, peaked between 1920 and 1929, when more than 5.6 million steelhead were planted. It is probable that most of these early planting efforts were comprised of fry and fingerling, which generally have a much lower survival rate than the yearling steelhead commonly planted today. The second period spans from 1939 to 1971 when very few hatchery steelhead were planted. During this period, however, the Russian River received more than 1.8 million outplants of fingerling steelhead "rescued" from summer-intermittent streams, 29 percent of which came from basins outside the Russian River. (These outplants are not included in the data in Table 3-21). The third distinct period is characterized by the outplanting activities of the DCFH and CVFF programs. More than 15 million steelhead were released from DCFH and CVFF between 1981 and 1998, representing 46 percent of all outplants listed in Table 3-18. During the start-up of DCFH in 1980 and 1981, eggs were obtained from Russian River adults captured within the basin, as well as from Mad River and Washougal River, Washington source stocks (R. Gunter, CDFG, pers. comm. 1999). All DCFH/CVFF steelhead broodstock since 1982 come from the Russian River basin. It is estimated that less than 1 percent of the 1981 to 1998 steelhead outplants came from out-of-basin broodstock sources.

There is no known information regarding the survival of fish from outplants prior to the DCFH/CVFF program. Even so, given the magnitude and duration of historical stocking, naturally-spawning steelhead within the Russian River probably represent a genetic conglomerate of many steelhead stocks. Similarly, steelhead broodstock used for the DCFH and CVFF programs are probably descendants of many stocks. Data are unavailable to quantify the degree of introgression that may have occurred due to historical stocking using out-of-basin broodstock. While the history of stock transfers in the Russian River suggests that genetic integrity has been compromised, the current policy of collecting broodstock exclusively from returns to the Russian River should allow selection and genetic drift to give rise to Russian River-specific stocks.

Broodstock Selection and Mating

Since 1982, the source of broodstock for Russian River steelhead outplants has been limited to adult fish trapped at DCFH and CVFF facilities (R. Gunter, CDFG, pers. comm. 1999). Broodstock for the DCFH program are collected from fish entering the DCFH ladder and trap, while those for the CVFF program are collected from fish entering the CVFF ladder and trap.

Adult collection and spawning protocols at DCFH and CVFF require systematic collection across the entire adult return period. Weekly capture goals are formulated using a distribution curve of adult returns, based on a running mean of adult returns during that week over the past several years. (A 9- to 11-year mean has been used in recent years, routinely showing that a vast majority of the adult return occurs within a 16-week period.) Steelhead program guidelines routinely aim to collect and spawn a minimum of 180 females at DCFH and a minimum of 120 females at CVFF, and generally 2.5 to 3 times those numbers for males. In practice, it is common that more individuals are spawned than are necessary to achieve egg-take goals, both in an attempt to increase genetic diversity and as a means to protect against catastrophic loss during incubation and early rearing.

Between 1991 and 1998, the number of female steelhead used as broodstock varied (Table 3-22). The number of males and jacks used as broodstock during this period was not recorded in hatchery records, but has been estimated based on the general spawning protocols in effect at the time. During this period, any naturally-spawned adults that voluntarily entered the traps were retained as broodstock whenever possible. The specific number of naturally-spawned adults used as broodstock is not known, but it has been stated that returning hatchery-reared individuals were the primary source of broodstock (R. Gunter, CDFG, pers. comm. 1999). The use of naturally-spawned steelhead as broodstock has not occurred since 1999.

Table 3-22 Steelhead Broodstock Spawning Levels at DCFH and CVFF from 1991 to 2003

Year[1]	DCFH Adults			CVFF Adults		
	Females (actual)[2]	Males (approx.)[3]	Jacks (approx.)[4]	Females (actual)[2]	Males (approx.)[3]	Jacks (approx.)[4]
1990-1991	159	395	2	NA	NA	NA
1991-1992	342	850	5	NA	NA	NA
1992-1993	365	907	5	106	263	2
1993-1994	342	850	5	123	306	2
1994-1995	292	726	4	92	229	1
1995-1996	250	621	4	118	293	2
1996-1997	241	599	4	117	291	2
1997-1998	157	390	2	107	266	2
1998-1999[5]	184	457	3	107	266	2
1999-2000[5]	184	457	3	128	318	2
2000-2001[5]	146	363	2	148	368	2
2001-2002[5]	179	445	3	169	420	3
2002-2003[5]	192	477	3	146	363	2

[1] CDFG operating year extends from July 1 of first year to July 30 of second year.
[2] Data regarding females spawned compiled from DCFH and CVFF annual reports.
[3] Total number of males (including jacks) estimated by assuming spawning ratio of 2.5 males:1 female (CDFG 2002).
[4] Number of jacks estimated assuming a 0.6 percent presence in the male population.
[5] Activities after 1997 to 1998 are not part of the baseline.

Rearing and Release

Incubation and fry rearing for the DCFH and CVFF steelhead programs is conducted inside the DCFH hatchery building. In early spring, the fish are transferred to outdoor raceways. In December, the first of three groups of CVFF steelhead is transferred from DCFH to the CVFF facility, where the fish undergo a 4- to 6-week acclimation period before being released to the East Fork Russian River. The second and third groups of CVFF steelhead are transferred in late January/early February and March, respectively. During this same period, DCFH steelhead remain at DCFH. As they reach their target release size (typically between mid-December and April), they are hauled via a transport truck and released into Dry Creek at Yoakim Bridge, approximately 3 miles downstream from DCFH.

Annual release data for the DCFH and CVFF steelhead programs are presented in Table 3-23, noting the total release number, pounds, and average size at release. The data reflect all releases that occurred between facility start-up through June 2003, even though the environmental baseline ends with the 1997 to 1998 year. Fingerling releases noted prior to the 1998 to 1999 year reflect the previous practice of releasing surplus eggs, fry, and fingerling into the drainage; this practice was terminated in July 1999. Similarly, some of the yearling release numbers prior to July 1999 may reflect the previous practice of releasing excess undersized fish that remained at the end of the season.

Table 3-23 DCFH and CVFF Steelhead Release History

Year[1]	Fingerling Number	Fingerling Pounds	Fingerling Avg FPP[2]	Yearling Number	Yearling Pounds	Yearling Avg FPP[2]
Don Clausen Fish Hatchery						
1981-1982	253,436	682	372	53,380	10,975	5
1982-1983	226,710	762	372	102,662	18,225	5
1983-1984	459,970	2,119	298	124,146	22,730	6
1984-1985	608,680	647	217	155,305	42,360	5
1985-1986	539,157	4,108	941	212,365	27,500	4
1986-1987	1,316,469	4,842	131	237,753	68,405	8
1987-1988	720,579	930	272	224,963	60,560	3
1988-1989	578,780	712	775	233,979	58,950	4
1989-1990	347,347	551	813	212,769	56,175	4
1990-1991	121,326	1,893	630	243,881	64,320	4
1991-1992	1,188,663	3,406	64	335,181	86,775	4
1992-1993	1,249,521	3,571	349	321,890	75,975	4
1993-1994	627,730	1,532	350	355,164	86,809	4
1994-1995	397,455	2,676	410	309,458	78,524	4
1995-1996	134,000	67	149	316,758	88,700	4
1996-1997	279,088	381	2000	312,388	86,376	4
1997-1998	119,681	522	733	348,734	99,295	4
1998-1999[3]	46,062	1,153	229	341,339	88,425	4
1999-2000[3]	0	0	0	300,000	75,000	4
2000-2001[3]	0	0	0	336,320	80,139	4
2001-2002[3]	0	0	0	284,378	85,950	3
2002-2003[3]	0	0	0	317,636	77,095	4
Avg - all years	333,975	1,419	354	309,707	80,462	4
Avg - releases	467,564	1,987	495	309,707	80,462	4
Coyote Valley Fish Facility						
1992-1993	0	0	0	165,469	26,839	6
1993-1994	227,313	365	372	213,872	46,472	5
1994-1995	107,667	238	298	235,416	44,659	6
1995-1996	76,670	6,950	217	224,702	44,647	5
1996-1997	122,188	594	941	206,333	40,400	4
1997-1998	110,981	369	131	242,438	48,528	8
1998-1999[3]	164,770	1,086	152	231,320	45,448	5
1999-2000[3]	0	0	0	229,451	43,813	5
2000-2001[3]	0	0	0	211,801	45,852	5
2001-2002[3]	0	0	0	206,264	49,047	4
2002-2003[3]	0	0	0	212,513	43,239	5
Avg - all years	73,599	873	159	216,325	43,540	5
Avg - releases	134,932	1,600	291	216,325	43,540	5

1. The CDFG operating calendar extends from July 1 of the first year through June 30 of the second year.
2. Avg FPP = average size (fish per pound) at release.
3. Releases made after the 1997-1998 year are not part of the baseline.

In general, the DCFH steelhead production goals of 300,000 fish have been routinely achieved since 1992, following improvements in rearing facilities and water supply that were completed that year. Similarly, the CVFF production goals of 200,000 fish have been met since the first year following startup. Survival from unfertilized egg to stocked yearling routinely surpasses the management goal of 50 percent.

Adult Returns

Adult returns to DCFH and CVFF are presented in Table 3-24. Since operations began, DCFH has achieved the steelhead mitigation goal of 6,000 adult escapement only one time. At CVFF, the mitigation goal of 4,000 returning fish has yet to be achieved. Peak returns occurred in 1997, when 3,727 adult steelhead were counted at CVFF. It is suggested that the survival estimate of 2 percent stated in the DCFH and CVFF management plan established optimistic and unrealistic expectations for adult escapement goals.

Table 3-24 History of Steelhead Trapped at DCFH and CVFF

Year[1]	DCFH				CVFF			
	Male	Female	1/2-Pound	Total	Male	Female	1/2-Pound	Total
1980-1981	148	185	0	333				
1981-1982	124	235	0	359				
1982-1983	322	242	0	564				
1983-1984	1,039	923	0	1,962				
1984-1985	369	468	0	837				
1985-1986	812	484	4	1,300				
1986-1987	519	696	36	1,251				
1987-1988	660	375	10	1,045				
1988-1989	453	421	17	891				
1989-1990	428	260	15	703				
1990-1991	239	181	3	423				
1991-1992	750	834	7	1,591				
1992-1993	1,378	1,289	2	2,669	182	120	8	310
1993-1994	856	895	9	1,760	229	198	13	440
1994-1995	3,561	4,525	14	8,100	1,147	1,054	9	2,210
1995-1996	2,135	1,958	12	4,105	1,129	980	6	2,115
1996-1997	1,729	1,910	9	3,648	1,793	1,934	8	3,735
1997-1998	656	687	1	1,344	619	932	8	1,559
1998-1999[2]	1,219	1,012	5	2,236	793	798	5	1,596
1999-2000[2]	1,509	1,794	11	3,314	976	1292	2	2,270
2000-2001[2]	1,941	1,537	2	3,480	929	995	4	2,270
2001-2002[2]	2,032	2,087	1	4,120	1,486	1,860	0	3,346
2002-2003[2]	1,488	1,854	0	3,342	959	1,087	1	2,047
Average	1,059	1,081	7	2,147	931	1,023	6	1,991

[1] The CDFG operating calendar extends from July 1 of the first year through June 30 of the second year.
[2] Activities after the 1997-1998 year are not part of the baseline.

Harvest Management

Current fishing regulations allow the take of hatchery-reared steelhead. (Steelhead releases from DCFH and CVFF are marked with clipped adipose fins.) Harvest of naturally-spawned steelhead is prohibited. While this strategy minimizes direct fishing mortality, indirect effects such as hooking mortality and harassment may still affect naturally-spawned adults. There are no current estimates of harvest levels of steelhead within the Russian River.

3.8.3.3 Chinook Salmon

Historical Stocking Activities

Between 1881 and 1998, approximately 8.7 million hatchery Chinook salmon were planted in the Russian River basin (Table 3-25). A detailed review of hatchery records conducted by Steiner Environmental Consulting (1996) revealed that at least six out-of-basin Chinook salmon stocks were introduced to the Russian River as a result of outplanting, using broodstock sources tracing back to North Coast, Sacramento River, and Wisconsin hatcheries. These out-of-basin broodstock sources (with the last known year of planting noted in parentheses) included the Eel River (1998), Klamath River (1956), Mad River (1953), Sacramento River (1964), Silver King Creek (1983), and Wisconsin (1986). The management plan developed for implementation of the DCFH program stated that Chinook salmon eggs from the Eel River system were acceptable to use to meet the enhancement goals for the DCFH Chinook salmon program. Russian River Chinook salmon served as the broodstock for approximately 6 percent of all outplants between 1881 and 1998 (Table 3-25).

Table 3-25 Broodstock Source, Stocking Year, and Number of Chinook Salmon Outplanted in the Russian River, 1881 to 1998

Broodstock Source	Years Outplanted	Total Outplants[1]
Russian River	1985, 87-90, 92-98	542,478
Eel River	1982, 84, 86-89, 96-98	218,257
Klamath River	1955-56	1,000,000
Mad River	1953	9,250
Sacramento River	1956, 59-60, 62-64	3,283,295
Silver King Creek	1982-83	70,000
Unknown		2,265,292
Wisconsin[2]	1982-86	1,337,624
Total		**8,726,196**
% Russian River Origin[3]		**6%**

[1] Data compiled from Steiner Environmental Consulting (1996) and DCFH (1996, 1997, and 1998). Some historical records are incomplete. This compilation is intended to convey general magnitude of hatchery planting rather than exact numbers.

[2] West Coast hatchery strains of Wisconsin strain Chinook salmon originate from the Green River Hatchery in Washington.

[3] Because planting records are incomplete, this is only an estimate based on numbers presented in this table. Out-of-basin sources were planted extensively in the past, but this practice was diminished and then discontinued in more recent years.

Distinct periods of Chinook salmon stocking activities were described by Steiner Environmental Consulting (1996). The first hatchery Chinook salmon plant occurred in 1881 with the release of 15,000 fish, and subsequent hatchery plantings were sporadic until 1949. In 1949, a consistent program was begun in an effort to establish a viable population of Russian River Chinook salmon, using early-run stocks of fall Chinook salmon. In 1962, it was decided that the failure of these efforts was likely due to the adversely high water temperatures encountered by the returning adult fish. Efforts from 1963 to 1970 used a later-run stock of fall Chinook salmon, but still failed to establish a viable population. With the implementation of the DCFH program in 1982, a systematic effort was made to develop a basin-adapted strain for the program by planting progeny of adults returning to the hatchery. Between 1980 and 1989, only 15 percent of Chinook salmon plantings came from Russian River broodstock captured at the DCFH facility; between 1990 to 1995, 100 percent of plantings came from returning Russian River broodstock (Steiner Environmental Consulting 1996). There have been no outplants for the DCFH Chinook salmon enhancement program since 1998.

There is no known information regarding the survival of fish from Chinook salmon outplants prior to the DCFH program. Recent monitoring efforts suggest that a naturally-spawning Chinook salmon population currently exists within the Russian River basin (see Section 2.2.3.3). Given the magnitude and duration of historical Chinook salmon stock transfers, it is likely that naturally-spawning Chinook salmon within the Russian River represent a genetic conglomerate of many stocks. Similarly, Chinook salmon broodstock for the DCFH program were likely to have been descendants of many stocks. Data are unavailable to quantify the degree of introgression that may have occurred due to historical stocking using out-of-basin broodstock. While the history of stock transfers in the Russian River suggests that genetic integrity has been compromised, the considerable efforts made after 1982 to collect broodstock from returns to the Russian River contributed to allowing selection and genetic drift to give rise to Russian River-specific stocks. A recent study (Hedgecock et al. 2003) indicates that Chinook salmon in the Russian River are not closely related to Central Valley or Eel River populations, and concludes that they belong to a diverse set of coastal populations.

Broodstock Selection and Mating

Russian River Chinook salmon broodstock for the DCFH program were collected from fish entering the DCFH ladder and trap. Adult collection and spawning protocols at DCFH require systematic collection across the entire adult return period. The original Chinook salmon program guidelines targeted a release of 1 million Chinook salmon smolts sized at 50 fish per pound, to achieve the escapement goal of 1,750 returning adult Chinook salmon returning to the Russian River system. The program estimated a need to collect 1.3 million eggs and spawn a minimum of 333 females to achieve the production guidelines, and, generally, there was a desire to collect 1.5 to 2 times those numbers for male broodstock. If there were insufficient Russian River Chinook salmon to achieve the program egg take goals, it was acceptable to transfer late-run Chinook salmon eggs from the Eel River system to meet the goals. Additionally, when the numbers of available eggs were less than the target, it was acceptable to rear fish to the yearling size of 10 fish per pound in an effort to increase their post-release survival.

Between 1993 and 1998, the number of female Russian River Chinook salmon used as broodstock varied, in direct response to the number of adult fish returning to the hatchery (Table 3-26). The number of males used as broodstock during this period was not recorded in hatchery records, but has been estimated based on the general spawning protocols in effect at the time. During this period, any naturally-spawned Chinook salmon that voluntarily entered the traps were retained as broodstock whenever possible. The specific number of naturally-spawned adults used as broodstock is not known, but it has been stated that returning hatchery-reared individuals were the primary source of broodstock (R. Gunter, CDFG, pers. comm. 1999). The DCFH Chinook enhancement program was terminated in 1999.

Table 3-26 Chinook Salmon Broodstock Spawning Levels at DCFH from 1993 to 2003

Year[1]	Females (actual)[2]	Males (approx.)[3]
1993-1994	0	0
1994-1995	9	18
1995-1996	11	22
1996-1997	7	14
1997-1998	7	14
1998-1999[4]	0	0
1999-2000[4, 5]	NA	NA
2000-2001[4, 5]	NA	NA
2001-2002[4, 5]	NA	NA
2002-2003[4, 5]	NA	NA

1 Operating year for CDFG extends from July 1 of first year to June 30 of second year.
2 Data regarding females spawned compiled from DCFH annual reports.
3 Total number of males estimated by assuming spawning ratio of 2 males: 1 female (CDFG 2002).
4 Activities after the 1997- 1998 year are not part of the baseline.
5 The Chinook salmon enhancement program was terminated in 1999.

Rearing and Release

Incubation and fry-rearing functions for the DCFH Chinook salmon program were conducted inside the DCFH hatchery building. Approximately 6 weeks after hatching, it was typical to transfer the fry into outdoor concrete raceways. Fish reared for release as smolts (sized at 50 fish per pound) were released to Dry Creek in April or May. Fish reared to the yearling size (greater than 10 fish per pound) were typically released to Dry Creek in November.

Annual release data for the DCFH Chinook salmon program are presented in Table 3-27, including the total release number, pounds, and average size at release. The data reflect all releases that occurred between facility start-up through June 2003, even though the environmental baseline ends with the 1997 to 1998 year. Returns of Chinook salmon have never allowed adequate egg take to achieve the release goal of 1 million smolts. Comparison of relevant data on adult returns and egg harvest indicates that Chinook salmon release numbers were directly related to availability of broodstock, and low-release numbers should not be construed as a reflection of hatchery operations. Survival from unfertilized egg to stocked yearling routinely surpassed the management goal of 50 percent.

Hatchery-reared Chinook salmon generally migrate to the ocean at a larger size than their naturally-spawned smolt counterparts. This suggests that direct predation may occur if hatchery releases overlap natural production on either a spatial or temporal basis. At the same time, larger individuals may emigrate more quickly than smaller individuals, decreasing the risk of freshwater predation and competition.

Table 3-27 DCFH Chinook Salmon Release History

Year[1]	Fingerling			Yearling		
	Number	Pounds	Avg FPP[2]	Number	Pounds	Avg FPP[2]
1981-1982	102,360	2,160	47	0	0	0
1982-1983	68,750	2,083	33	20,900	3,074	7
1983-1984	66,120	1,740	38	0	0	0
1984-1985	211,510	4,697	45	0	0	0
1985-1986	884,520	18,595	48	0	0	0
1986-1987	92,765	1,835	51	34,592	3,225	11
1987-1988	54,150	1,275	42	0	0	0
1988-1989	237,450	6,800	35	0	0	0
1989-1990	13,770	270	51	36,037	3,837	9
1990-1991	0	0	0	0	0	0
1991-1992	113,525	2,525	45	0	0	0
1992-1993	8,877	269	33	0	0	0
1993-1994	0	0	0	50,300	4,800	10
1994-1995	0	0	0	0	0	0
1995-1996	0	0	0	25,923	13,000	2
1996-1997	0	0	0	31,990	10,000	3
1997-1998	0	0	0	7,800	750	10
1998-1999[3]	0	0	0	11,730	2,300	5
1999-2000[3, 4]	0	0	0	0	0	0
2000-2001[3, 4]	0	0	0	0	0	0
2001-2002[3, 4]	0	0	0	0	0	0
2002-2003[3, 4]	0	0	0	0	0	0
Avg - All Years	84,264	1,913	21	9,967	1,905	3
Avg - Releases	168,527	3,826	43	27,409	5,239	7

1 The CDFG operating calendar extends from July 1 of the first year through June 30 of the second year.
2 Avg FPP = average size (fish per pound) at release.
3 Releases made after the 1997-1998 year are not part of the baseline.
4 The Chinook salmon enhancement program was terminated in 1999.

Rearing of all DCFH Chinook salmon used Lake Sonoma water, and releases occurred in Dry Creek approximately 3 miles downstream from the hatchery. Due to these rearing and release locations, all Chinook salmon were acclimated to a certain degree within the Russian River system, suggesting that straying to out-of-basin rivers is unlikely to be a great concern. Adult Chinook salmon would likely return to release streams rather than non-natal tributaries.

Adult Returns

Adult returns to the DCFH are presented in Table 3-28. During the 1980 to 1998 period when the Chinook salmon enhancement program was conducted, the maximum capture of adult Chinook salmon in the DCFH trap was 304 fish. It is unknown what harvest levels of Chinook salmon occurred during this period. It is unlikely that the escapement goal of 1,750 Chinook salmon to the mouth of the Russian River was ever achieved. It is suggested that the survival estimate of 0.175 percent stated in the DCFH management plan established optimistic and unrealistic adult escapement goals.

Table 3-28 History of Chinook Salmon Trapped at DCFH

Year[1]	Male	Female	Grilse	Total
1980-1981	0	0	0	0
1981-1982	0	0	0	0
1982-1983	1	0	0	1
1983-1984	2	1	1	4
1984-1985	7	1	0	8
1985-1986	65	0	0	65
1986-1987	50	25	36	111
1987-1988	176	4	124	304
1988-1989	151	61	21	233
1989-1990	8	6	3	17
1990-1991	67	0	32	99
1991-1992	77	46	2	125
1992-1993	15	22	3	40
1993-1994	8	0	13	21
1994-1995	59	9	17	85
1995-1996	18	12	3	33
1996-1997	25	11	7	43
1997-1998	16	14	19	49
1998-1999[2]	1	0	3	4
1999-2000[2, 3]	2	0	0	2
2000-2001[2, 3]	21	5	3	29
2001-2002[2, 3]	5	3	2	10
2002-2003[2, 3]	181	83	42	306
Average	**42**	**13**	**14**	**69**

1 The CDFG operating calendar extends from July 1 of the first year through June 30 of the second year.
2 Activities after 1997 to 1998 are not part of the baseline.
3 The Chinook salmon enhancement program was terminated in 1999.

Harvest Management

Fishing regulations would allow the take of hatchery-reared Chinook salmon (Chinook salmon releases are marked with clipped adipose fins), but the current lack of hatchery Chinook salmon production precludes the harvest of Chinook salmon within the Russian River basin. Harvest of naturally-spawned Chinook salmon is prohibited. While this strategy minimizes direct fishing mortality of Chinook salmon, indirect effects such as hooking mortality and harassment may still occur. There are no current estimates for incidental harvest levels of Chinook salmon within the Russian River.

Rearing for Out-of-Basin Programs

DCFH participates in an egg-banking program for a unique run of late fall Chinook salmon from the Eel River. Eggs from fall Chinook salmon spawned in the Eel River drainage are brought to the DCFH for incubation. At the time of spawning, adult fish used as the source of these eggs are tested for viral pathogens and screened for *Renibacterium salmoninarum*, the causative agent of bacterial kidney disease (W. Cox, pers. comm. 1999). Upon arrival at the DCFH, the Eel River eggs are disinfected with iodophore solution to remove surface pathogens that may be present. Egg lots are incubated separately until completion of viral certification, after which time the egg lots may be combined. When the eggs reach the eyed-egg lifestage, half are sent to Mad River Hatchery to continue incubation and rearing. The remaining eggs are kept at DCFH, reared to the juvenile stage, then returned to the Eel River where they are imprinted on Eel River water and released.

3.8.4 FACTORS AFFECTING SPECIES ENVIRONMENT

Potential effects on listed coho salmon, steelhead, and Chinook salmon in the Russian River basin that may arise from the existing fish facility operations were evaluated in *Interim Report 2 Fish Facility Operations* (FishPro, Inc. and ENTRIX, Inc. 2000). Operating practices of the DCFH and CVFF facilities reflect a commitment to minimize effects on listed populations. Procedures for waste treatment demonstrate continuous compliance with recommended discharge standards for water quality. The facilities have been able to effectively manage routine fish diseases. Recent changes in policy regarding importation of stocks have resulted in minimal likelihood of effects on listed stocks due to disease. Similarly, current operations relating to production goals and harvest are the most practicable approach to minimizing ecological effects such as competition, predation, and overexploitation.

In general, there is a low risk of adverse effects to listed fish populations. Given the mixed stock history of DCFH and CVFF, adult salmonids currently returning to the facility may be of mixed origin. Therefore, the risk of outbreeding depression is potentially higher than would be the case had broodstock always been collected locally. Over the course of the Chinook salmon program at DCFH, the numbers of adult Chinook salmon returning to the hatchery was frequently low. As a result, the number of Chinook salmon spawned as broodstock was often below the generally-recommended minimum of 100 adult pairs, and therefore hatchery Chinook salmon may have incurred an unfavorable level of inbreeding. There is a low risk of artificial selection in the hatchery program because traditional rearing techniques are used and because naturally-spawned individuals are not used as broodstock. Hatchery production of steelhead may contribute to competition with naturally-spawned steelhead, and there is a low risk that hatchery fish may prey on listed naturally-produced fish because they are released at a larger size. However, steelhead releases are not generally made in primary spawning or rearing habitat, and the volitional release strategies employed at CVFF minimize these risks even further.

3.9 SUMMARY OF FACTORS AFFECTING SPECIES ENVIRONMENT

Potential effects to salmonid populations from SCWA and USACE activities in the Russian River can be grouped into several subcategories:

- Operational Effects
  - flow recessions
  - entrainment and impingement
  - impediments or barriers to outmigration
- Effects Related to Water Management
  - summer flows
  - winter flows
  - operation of the Wohler Inflatable Dam
- Channel Maintenance Activities
- Fish Production Facilities

Dam and water diversion facility operations may result in effects to juvenile salmonids, including stranding, entrainment, and impingement, and barriers to outmigration.

D1610 flow requirements are currently one of the primary factors affecting salmonid populations in the Russian River system. Flow (which determines water velocity and depth) is considered to be a key determinant in the quantity and quality of physical salmonid habitat in areas downstream of the dams. Flow also influences water quality parameters including temperature and DO, thereby affecting habitat quality. In the Russian River system, flows exert their effects primarily on the quantity and quality of summer rearing habitat available. During the winter months, project operations have a much lower effect on fish habitat, as flow levels are influenced primarily by runoff from unregulated tributary streams.

Fish production facility operations may also affect naturally-reproducing populations of listed fish species through competition, predation, and effects to genetic integrity. Other influences on salmonid populations are related to the presence of predatory species in areas of warmer, slow-moving water.

3.9.1 Operational Effects

Operation of various USACE and SCWA facilities in the Russian River system have the potential to affect listed fish species. Potential effects related to operations at Coyote Valley Dam and the Mirabel and Wohler diversion facilities are discussed below.

3.9.1.1 Flow Recessions

Coyote Valley Dam Inspection and Maintenance Activities

Ramping at higher levels of flow (greater than 250 cfs) during flood control operations holds less risk for stranding young fish than when flows are lower. Releases from the dam are decreased (ramped down) or cease during inspection and maintenance activities. Two issues arose in the evaluation of potential effects on juvenile salmonids: flow reduction during inspection and maintenance activities, and timing of inspections. When flows are decreased (ramped down) or cease, downstream habitat is subjected to flow recessions and dewatering. Stranding of juvenile salmonids has been documented. When inspections occur in the late winter/spring, fry (small fish are more susceptible) may be present. Under baseline conditions, the criterion for ramping-down releases from the dam when flows are less than 250 cfs is 50 cfs/hr.

Use of the current 50-cfs/hr ramping rate during pre-flood inspections and maintenance activities at Coyote Valley Dam does not provide protection from stranding for either fry or juveniles. Ramping effects may be observed in the East Fork and mainstem Russian River for several miles below the Forks. Coyote Valley Dam operations will not significantly affect listed species on the mainstem Russian River below the Forks during maintenance and inspection activities if there is sufficient flow at the Ukiah gage. However, lack of bypass flow capability may cause dewatering and stranding on the East Fork.

Coyote Valley Dam Flood Control Operations

Fish stranding may occur due to ramping down of streamflows during flood control operations at high reservoir releases (250 to 1,000 cfs) and at lower reservoir releases (less than 250 cfs). Fry and juveniles are most vulnerable to stranding during ramping due to their poor swimming abilities (Hunter 1992). However, the potential for stranding is low, given that there is generally considerable flow at the Forks from the mainstem Russian River to attenuate ramping effects. Often, flows are greater than 2,500 cfs at the Forks during flood operations ramp-down, and there is a backwater effect on the East Fork, which would attenuate stage changes (P. Pugner, USACE, pers. comm., 2000). Current operational conditions associated with interim ramping rates appear to provide adequate protection to listed species.

Mirabel Inflatable Dam

When the inflatable dam is raised or lowered, water levels downstream and upstream, respectively, of the dam can drop, creating an opportunity for stranding juvenile fish.

When the inflatable dam is lowered, flow recessions in approximately 3.2 miles of river upstream have the potential to result in stranding or displacement of salmonids. The risk of stranding is highest during a spring deflation of the dam because juvenile fish (including fry), which are more susceptible than larger fish, are more likely to be present. Several factors reduce this risk.

Generally, habitat in the 2-mile reach that is affected by impounded water above the inflatable dam does not have characteristics that increase the potential for stranding. When the inflatable dam is not inflated, the channel upstream of the dam is primarily run-habitat, with fine gravel, cobble, and boulder substrates. It is a single-channel river with a relatively straight trajectory through the area and relatively few structural features that would create low areas outside the main channel. The slopes of the river margins have a low gradient, which could increase the risk of stranding, but are sloped to the main channel. The wetted channel extends from bank to bank whether the dam is inflated or deflated, so dewatering of the riverbed is unlikely. Furthermore, the dam was lowered on average only 1.5 times per year over a recent 20-year period, and deflation usually occurs in the fall when small salmonids are less likely to be present. Deflation of the inflatable dam presents a low risk of stranding to juvenile salmonids if it is performed slowly enough.

Inflation of the dam usually occurs when river flows have declined from winter levels, generally in the spring. Although water may continue to spill over the dam during inflation, flow recessions occur downstream of the inflatable dam. Greater numbers of juvenile fish are likely to be present, and downstream habitat is more complex. Therefore, the risk of stranding young fish is higher.

3.9.1.2 Entrainment and Impingement

Operations of SCWA's diversion facilities at Mirabel and Wohler potentially result in impingement or entrainment of listed fish species. Fish may also be entrained in the infiltration ponds when flood flows overtop the levees.

The fish screens at the Mirabel diversion conform to most of the NOAA Fisheries screening criteria for protecting juvenile lifestages of salmonid species, but not fry. Coho salmon fry are generally found in tributaries rather than the mainstem, and therefore are at a very low risk. The timing of the Mirabel diversion operation normally does not overlap substantially with the juvenile outmigration period for Chinook salmon. There is a larger overlap with the diversion operation and juvenile steelhead outmigration period. Steelhead fry that may be present and early Chinook salmon downstream migrants may be at risk. However, the dam is generally inflated in mid-spring, when average fish lengths are beginning to be larger than fry-size.

The Wohler diversion system is considerably smaller than the one at Mirabel, but is ineffectively screened. When water is diverted to the Wohler infiltration ponds, fry and juvenile salmonids that are rearing or migrating through the area are at risk. Migrating juveniles of all three listed species, particularly steelhead, may be affected.

When flood flows overtop the infiltration ponds at Mirabel and Wohler, juvenile fish can be entrained. Because the Mirabel ponds overtop infrequently, migrating salmonids are at a low risk, and recent modifications for more effective fish-rescue efforts minimize this risk.

Prior to 1999, fry and juvenile salmonids could become trapped in the Wohler ponds when stormflows overtopped the levees surrounding the ponds. Because the Wohler ponds historically overtopped more frequently, migrating salmonids were at a higher risk of entrainment. While fish-rescue operations may have reduced the risk, some juvenile steelhead have been lost to injury or stress during rescue operations. Fish rescues were conducted after the levees overtopped, but at times they were delayed for up to 2 weeks until access was possible.

3.9.1.3 Impediments or Barriers to Outmigration

The Mirabel inflatable dam does not impede adult salmonid passage while lowered, and when in operation, the fish ladders are effective at passing adults of all species without delay.

The inflatable dam has been identified as a potential impediment to steelhead smolt outmigration (Manning et al. 2001, Manning 2003). When inflated, the dam at Mirabel impounds water for 3.2 miles upstream. This impoundment decreases current velocity, which has the potential to delay emigrating smolts. Data from SCWA’s studies suggest that smolts that are physiologically prepared to emigrate experience a minor delay through the impounded area, but the delay seems to occur primarily at the dam. Recent studies by SCWA (Manning et al. 2001, Manning 2003) have shown that steelhead smolts tend to accumulate above the dam, but most fish pass successfully by swimming over the dam crest. Chinook salmon smolt emigration through the area does not appear to be delayed by the dam (Chase et al. 2002).

3.9.2 Effects Related to Water Management

Under D1610, flow levels are generally similar during the winter months to what they would be without the project. These flows are generally acceptable for the lifetstages that occur during this time of year, including upstream migration, spawning, incubation, and emigration. During the summer and early fall months (June through October) the minimum instream flow requirements of D1610 have resulted in streamflows in the Russian River and Dry Creek that are dramatically higher than the natural flow regime. It is during this season that effects related to water management occur, primarily affecting summer rearing. These flows affect both the quality and quantity of rearing habitat due to the resulting velocities and depths, but also influence water temperatures.

3.9.2.1 Summer Flows

Based on the analyses of the effects of D1610 flows presented in *Interim Report 3* (ENTRIX, Inc. 2002b) and the results of the Flow/Habitat study conducted in the fall of 2001 (ENTRIX, Inc. 2003b, Appendix F), the flows occurring under D1610 at current demand levels results in velocities that are generally higher than optimal for juvenile salmonid rearing in most faster water sections of the upper Russian River and Dry Creek (i.e., riffle and run habitat types). However, a substantial amount of suitable rearing habitat remains in pools and along channel margins where velocities are more suitable. In *dry* water supply conditions, this situation is exacerbated in Dry Creek, as flows are increased to meet demand and to avoid dewatering Lake Mendocino. The flows in the upper Russian River are reduced, which would improve velocity conditions in that area.

Water temperatures under D1610 at current demand levels are generally acceptable for rearing in Dry Creek and the upper Russian River, but reach very stressful levels below Cloverdale. These water temperatures are such that they may preclude salmonid rearing during most of the summer. This occurs under both *all* and *dry* water supply conditions. Additionally, under *all* water supply conditions, the cold-water pool in Lake Mendocino may be depleted in September, which results in stressful temperatures in the upper Russian River during September and October.

Under the buildout demand levels, the additional water to meet the projected increased demand is provided from Lake Sonoma. Thus, flows in the upper and middle Russian River are similar to those under current demand levels, providing similar habitat conditions. Flows in Dry Creek are increased substantially, especially under *dry* water supply conditions, when they would more than double over current levels. This would result in much poor rearing conditions for juvenile salmonids in Dry Creek.

Temperatures under the buildout demand levels would remain similar in the Russian River, but would be lower and more favorable in the lower portion of Dry Creek. This improvement, however, is likely offset by the poorer habitat resulting from the higher water velocities at these flow levels.

The Estuary is important for adult and juvenile passage for all three listed species, and may provide important rearing habitat for steelhead and Chinook salmon. The current summer flow regime has the potential to affect several components of salmonid habitat in the Estuary. These include water quality (including temperature, DO, and salinity), primary productivity and the availability of aquatic invertebrates, availability of shallow water habitat, and the concentration of nutrients and toxic runoff. Augmented summer flow results in the need for an artificial breaching program that may also affect these components, and may allow adult Chinook salmon early access to the river when flows and temperature may be unsuitable.

Under D1610 flows, the sandbar that forms across the river mouth is breached several times in the summer/early fall, which creates fluctuating DO, temperature, and salinity conditions in the Estuary. Fluctuating salinity and low DO conditions decrease invertebrate populations upon which juvenile salmonids feed (ENTRIX 2002b). In addition, the current management plan results in the sandbar being open in the early portion of the migration period for Chinook salmon (late August and September). Thus, adult Chinook salmon can enter the river system before river conditions are suitable for upstream migration. The augmented flow in the Estuary may have several beneficial effects, including the dilution of agricultural and urban runoff and dilution of untreated waste from failing on-site sewage disposal systems throughout the watershed.

3.9.2.2 Winter Flows

Operations at Coyote Valley Dam and Warm Springs Dam regulate flood flows during winter storms. The dams moderate the naturally flashy conditions by reducing peak flows and maximum ramping rates. There are three issues related to potential effects on channel geomorphic conditions: scour of spawning gravels, streambank erosion, and channel maintenance/geomorphology. Sufficient flows should be available to maintain channel geomorphology for high-quality fish habitat, but high flows can scour spawning gravels and redds, as well as contribute to excessive bank erosion. Effects of flood control operations were evaluated in *Interim Report 1* (ENTRIX, Inc. 2000a).

The evaluation indicates that winter flows in the mainstem Russian River are sufficient to mobilize and flush spawning gravels, which maintains good quality spawning habitat. Flood control operations do not have a significant effect on spawning gravel scour in the Middle or Upper reaches of the Russian River. However, flows in Dry Creek below Warm Springs Dam can potentially be strong enough to scour redds and mobilize spawning gravels.

On the mainstem Russian River, potential effects of flood flows were evaluated for steelhead and Chinook salmon only, since coho salmon do not use the mainstem for spawning. The Upper and Middle reaches, between Ukiah and Alexander Valley, were included in the assessment. Downstream of Alexander Valley, spawning habitat is limited (Winzler and Kelly 1978, Cook 2003b), and flood control operations have a diminishing effect on high-flow conditions; the lower mainstem reach therefore was not considered for evaluation.

The evaluation indicates that stability of steelhead spawning gravels is very good in the upper mainstem reach. There is a moderate potential for scour of Chinook salmon gravels, but an acceptable balance between periodic streambed mobilization and spawning gravel stability. The lower incidence of scour of steelhead gravels compared with Chinook salmon gravels is at least partially due to the later-season incubation period for steelhead. During the steelhead incubation period, the incidence of flows that might scour spawning gravels is fairly low in the Upper Reach.

In the Middle Reach of the Russian River at Alexander Valley, spawning gravels are less stable and subject to slightly more frequent scour than the Upper Reach. The evaluation indicates moderately stable conditions for Chinook salmon, and moderately, but slightly less stable conditions, for steelhead. Higher discharges due to tributary flow accretion probably account for the greater incidence of scour in the Middle Reach compared with the Upper Reach.

On Dry Creek, effects of flood control operations were evaluated for coho salmon, steelhead, and Chinook salmon. There is a reasonably good balance between expected periodic streambed mobilization and spawning gravel stability for successful reproduction of Chinook salmon, and an acceptable balance for successful steelhead reproduction. Coho salmon, which use smaller gravels for spawning, would be subject to a greater frequency of scour than either steelhead or Chinook salmon redds.

3.9.2.3 Operation of the Wohler Inflatable Dam

Operation of the inflatable dam may slightly increase the risk of predation on migrating Chinook salmon or a few rearing steelhead. YOY steelhead have been found in the area, but not YOY coho salmon. The inflatable dam impounds water, resulting in an increase in pool habitat that has the potential to increase habitat for the warmwater fish community, including predators. This potentially increases the risk of predation on migrating juveniles. The ability of predators to consume juvenile salmonids depends on their relative sizes; larger predators are most likely to prey on young fish. Sampling in the Wohler Pool in 1999 through 2003 found predators (e.g., smallmouth bass) in vastly larger numbers in young-age classes than older-age classes. However, older, larger predators that can prey on young salmonids were found in very low numbers (Chase et al. 2003).

Temperature monitoring in both the impounded area and in the free-flowing river areas found favorable temperatures for warmwater predator populations. However, monitoring studies also found that the impoundment created by the inflatable dam was not responsible; water temperature increased only slightly (approximately 0.5°C) above water temperature upstream of the impoundment (Chase et al. 2002).

3.9.3 Channel Maintenance Activities

Interim Report 5 (ENTRIX, Inc. 2001b) identified several adverse modifications to salmonid habitat due to channel maintenance activities in constructed flood channels. These maintenance activities include sediment maintenance and vegetation maintenance.

Sediment maintenance in constructed flood control channels reduces fish passage to spawning and rearing habitat and restricts downstream migration. Most sediment maintenance occurs in channels in urbanized areas where low summer flows reduce water quality and there is poor summer rearing habitat. Therefore, sediment maintenance actions may have a substantial effect on passage in some channels where the streambed is flattened removing the thalweg. Direct effects to rearing habitat in the maintained portion of the channel are of lower concern.

Vegetation maintenance occurs in constructed flood control channels and, to a more limited extent, in natural waterways. The urbanized portion of the watershed in Santa Rosa and the Cotati-Rohnert Park areas contain most of the constructed flood control channels. Natural waterways and constructed flood control channels in the Rohnert Park area are generally low-gradient, run through a valley plain to the Laguna de Santa Rosa, and contain poor summer rearing habitat. The Laguna de Santa Rosa has important wetland and flood control functions for this part of the watershed. Santa Rosa Creek also drains to the Laguna de Santa Rosa, which, in turn, drains to Mark West Creek. Channel maintenance activities on constructed and natural waterways in this part of the Mark West Creek watershed, including the Santa Rosa Creek watershed, have the potential to affect coho salmon and steelhead because this area contains good rearing and spawning habitat for these species. Chinook salmon and steelhead may be affected in the Santa Rosa Creek watershed.

SCWA and MCRRFCD channel maintenance activities related to USACE obligations for flood control structures occur in Dry Creek and the mainstem Russian River in Sonoma and Mendocino counties. Loss of riparian vegetation due to maintenance of bank stabilization structures under USACE obligations on Dry Creek and the mainstem Russian River may have a moderate effect when shade canopy and cover are reduced.

SCWA and MCRRFCD have conducted activities in the mainstem of the Russian River related to streambank stabilization. These activities, as conducted under baseline practices, potentially have a substantial effect on populations of listed fish species because habitat in large amounts of river and stream channel can be altered. This is particularly true upstream of Asti in Mendocino County because some of the most valuable mainstem rearing and spawning habitat occurs there. Gravel bar grading and vegetation removal potentially affects listed fish species by reducing pool habitat formation and loss of high-flow refuge, as well as reducing shade canopy and cover.

3.9.4 Fish Production Facilities

Hatcheries may have adverse effects on listed fish species. Hatchery-bred fish may affect naturally-reproducing stocks through competition, predation, and changes in genetic integrity. Evaluation of hatchery operations in *Interim Report 2* (FishPro and ENTRIX, Inc. 2000) indicated that, in general, there is a low risk of adverse effects to listed fish.

Given the mixed stock history of DCFH and CVFF, adult salmonids currently returning to the facility may be of mixed origin. Therefore, the risk of outbreeding depression is potentially higher than would be the case had broodstock always been collected locally. Over the last 4 years of the Chinook salmon program, the numbers of female Chinook salmon returning to the hatchery decreased considerably, reflecting the shift to local broodstock rather than out-of-basin sources. The numbers of Chinook salmon spawned during that time was well below the suggested minimum of 100 adult pairs; therefore, hatchery Chinook salmon may have had an unfavorable level of inbreeding. There is a low risk of artificial selection in the hatchery program, because traditional rearing techniques are used and because the naturally-spawned individuals are not used as broodstock. Hatchery production of steelhead may contribute to competition with naturally-spawned steelhead, and hatchery fish may prey on listed natural fish because they are released at a larger size. However, steelhead releases are not generally made in primary spawning or rearing habitat, and the volitional release strategies employed at CVFF minimize the risk even further.

Operating practices of the DCFH and CVFF facilities reflect a commitment to minimizing effects on listed populations. The facilities maintain good track records on the ability to manage routine fish diseases, and recent changes in policy regarding importation of stocks have resulted in minimal likelihood of effects on listed stocks through disease. Current operations relating to production goals and harvest indicate that the best practicable approach is being utilized in minimizing ecological effects such as competition, predation, and overexploitation. Procedures for waste treatment demonstrate continuous compliance with recommended discharge standards for water quality.

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